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CONTINUITY OF EDUCATION.*

BY FREDERICK P. FISH.

The wisest of kings has told us that —

> "To every thing there is a season,
> And a time to every purpose under the heaven."

The graduation period of our universities is above all a season for congratulations and best wishes to those who have completed their preliminary training and are about to enter upon the strenuous work of after life. These I cordially tender. But it is also a time at which an hour may well be spared for reflecting upon the nature and character of the change in effort and aspiration that comes with the completion of the courses in the university, that the relation of the future to the past, of the new life to the old, may be more clearly apprehended. I shall touch upon but one phase of the matter, although many are well worthy of consideration, and shall only hope to emphasize a thought that is undoubtedly familiar to you all. It cannot be necessary to do much more than remind you that your education has by no means been completed by your successful mastery of the admirable courses of instruction offered to you by this great university, but that it will continue throughout your lives. While I shall enlarge to some extent on this subject, my chief effort will be to impress upon you that exactly as the extent to which each one of you has profited by his training in the Columbia Schools of Applied Science, has depended not merely upon his individual capacity but even more upon the point of view

* Address to the graduating class of the Schools of Mines, Engineering and Chemistry, Columbia University, May 26, 1908.

and spirit with which he has approached his work, so in the future the degree and character of the education which each man will receive and the profit and pleasure of it to him, are matters largely within his own control.

First, however, I must say something as to education and its aims and purposes, as I gather them from observation and from history; for views as to the continuity of education cannot be estimated at their true value unless there is a definite understanding of the nature, characteristics and purposes of the education that is to be continued.

It is generally conceded that a prime function of education is to train the individual, that he may be able to deal with the affairs of life, complicated and variable as they are, with intelligence, honesty, efficiency and sincerity; to fit him to adjust and readjust his relations to other men and to affairs as occasion may require; to excite his sympathy with all that is noble and beautiful in life and in nature; to develop his moral and intellectual powers so as to make him, to as great an extent as possible, effective, useful to himself and to others, and as far as may be, a happy and successful man.

It is interesting to find how early this broad idea of the function of education was recognized. Three thousand years ago it was stated with considerable definiteness by the great master who recorded with amazing vividness and power, as incident to his wonderful story of the Trojan War, the views of life then current. In the ninth book of Homer's Iliad, the old man Phœnix reminds his former pupil, the swift-footed Achilles, son of Peleus, of the duties imposed upon him as tutor when he was placed in charge of the young hero's education. These are his words:

"To thee did the young knight, Peleus, send me the day he sent thee to Agamemnon forth from Phthia, a stripling yet unskilled in equal war and in debate, wherein men are preëminent. Therefore sent he me, to teach thee all these things, to be both a speaker of words and a doer of deeds."

An education which trains a man to be a speaker of words and a doer of deeds must be most comprehensive. It involves every form of intellectual, moral, æsthetic and physical training. Such was constantly the Greek ideal, which was so well attained in the little city of Athens and the few square miles of surrounding country. Although the Greek race failed politically, the failure was not due to its theories of education; nor altogether to the fact that

at the climax of its greatness, it departed from those theories by allowing the "speaking of words" to assume a far more important place in its thoughts and aspirations than the "doing of deeds." The effects of the Greek method of training have been lasting and of prime importance in the history of the world.

Looked at merely from this point of view, the things taught are relatively of little importance. It is certainly of value to have in mind as many items of information as possible, whether of fact or theory, but the great thing is training, and a man is well educated even if most that he has learned is forgotten, provided the intellectual and moral faculties have been so developed as to give a right view of life, and to insure a firm grasp on each situation as it arises, with the power of accurate analysis and synthesis and the capacity for sound decision and of strong, definite and discreet action in pursuance of that decision.

There has, however, always been another type of education which, as a practical matter, was even of greater importance than that to which attention has just been called. It is the learning of things for the sake of applying the knowledge so acquired in the practical affairs of life. From the days "when Adam delved and Eve span," the very existence of the human race, and everything growing out of the presence of that race on the earth, have required that the vast majority of its members should work. Some of them have worked with their hands; some with their brain; and some with both hands and brain. The work has seemed to be primarily in the interest of the individual that he might acquire the necessities and luxuries of life. In reality, however, it has been even more in the interest of the race, that it might thrive and prosper.

Everyone who has worked has of necessity received a real education for the work he had to do. The day laborer has to be educated to use the pick and shovel; the housewife to do the work of the family; the farmer, the mechanic, the musician, the hunter and the fisherman, the tradesman, the sailor and the soldier have all been educated men in a true sense even if they never saw a book or attended a school. Each has learned and has been taught to do the particular thing in the world's work that by his own will or by chance has been assigned to him.

This same kind of education, that is, the learning of special things for vocational purposes, is equally essential to the lawyer,

the judge, the scientist, the statesman, the artist, the business man, the physician, the engineer and the cshtmie. Without it, they cannot play their parts.

Only within recent years has it been generally recognized that special teaching institutions were required in the interest of education for the vocations. It is true that schools of law, theology and medicine existed in the Middle Ages, but it is probable that by far the greater number of lawyers and doctors have learned their law and their medicine otherwise than by systematic schooling. Such was certainly the case even in this country up to a few years ago.

There were until very recently substantially no schools for the other trades and professions. The special education, fitting him for his work, of the engineer, the farmer, the business man and the chemist, like that of the tradesman, the mechanic, the artist and the housekeeper, was based almost altogether upon imitation. Exactly as the primeval hunter learned from older and more experienced men the habits of animals and how to stalk or snare them, and as the farmer's son absorbed his father's methods of tilling the soil and of sowing seed and caring for and gathering the crop, so the engineer, chemist, business man and manufacturer learned their respective arts by associating with their elders and absorbing while in active work the results of the training and experience of former generations.

There was but little recognition of the need of any systematic school education for vocations.

Is is a far cry from Homer of three thousand years ago to John Locke of the seventeenth century, but the latter's thought had not progressed far beyond that of Phœnix and Peleus. In a well known passage in his "Conduct of the Understanding," Locke says:

"The business of education is not to make the young perfect in any one of the sciences, but so to open and dispose their minds as may best make them capable of any, when they shall apply themselves to it. It is therefore to give them this freedom that I think they should be made to look into all sorts of knowledge and exercise their understanding in so wide a variety or stock of knowledge. But I do not propose it as a variety and stock of knowledge but a variety and freedom of thinking, as an increase of the powers and activities of the mind, not as an enlargement of its possessions."

Locke thus limited the field of systematic education to the effort so to develop the student's faculties that he could afterward take

up as his life's work any vocation that attracted him and by reason of his intellectual training absorb, largely by imitation and association, the principles of the art to which he was to devote himself and the facts relating to it, without the necessity for a school education especially directed to that end.

Whether John Locke was right in his day and generation need not be discussed. There have been vast changes in industrial and social conditions since then. A theory which was sound even sixty years ago, may well require revision in view of the extraordinary developments of the past half century. It does not seem an exaggeration to say that our industrial and business conditions have changed more since the beginning of our Civil War than in all recorded history prior to that date. The change in social conditions has also been most striking. The effect upon our society of the elimination of space and time that has followed the application of electricity to the useful arts and the recent development of our transportation systems, together with the striking modifications of our manufacturing methods that have characterized the past few years, has been most far reaching. Among other things it can easily be shown that our great organizations of capital and labor, with the conflicts, trials and uncertainties resulting from them, have developed by an inevitable evolution from these new conditions.

For reasons that are obvious but which I have no time to present, it is to-day possible for neither engineers or chemists on one hand nor for artisans on the other, to get an adequate vocational training in the old way. Systematic education is required. The advanced technical schools of this country, of which those of Columbia University are an admirable type, are caring for the engineers and chemists. They form a recognized and important part of our educational system. Every good citizen who has the welfare of his fellow citizens at heart should coöperate in the effort to secure everywhere adequate industrial schools for the training of mechanics and artisans. There is no one thing upon which our prosperity more largely depends.

While there is no question as to the absolute necessity of the university technical school, no doubt as to the great value to the engineer and chemist of a systematic training in applied science as preliminary to actual work, it cannot be denied that the older views of education to which I have referred, were well founded. The criticism to be made upon them is that they were narrow and

incomplete. All agree that no scheme of education is effective which does not develop character, breadth of view and a general capacity for dealing with men and things outside of as well as within the field of specific professional work. But it is equally clear that the pursuit of exact knowledge of the kind that will be useful in professional work ought to be effective in promoting general culture. There can be no magic in one study rather than in another. Is not a training in mathematics sure to develop the logical faculty? What could stimulate the imagination more than the wonders of electricity? Can any subject cultivate the habit of accuracy of observation and of thought to a greater degree than the applied sciences? Is it possible to study the applications of the laws of nature, which are absolute truths, without a strengthening of the moral as well as of the intellectual fiber? Can there be a greater inspiration to industry, integrity and clearness of vision than a consideration of the wonderful achievements of the philosophers, investigators and inventors, who have made our applied science what it is?

In so far as there is any danger that a professional training in the scientific schools of the university will not result in the "state of mind" which is the fruit of liberal training, it must be for a reason outside of the subject matter taught.

Surely, every man needs a liberal education to as large an extent as possible. He also needs training in his special work. It seems certain that each of these fields of preliminary training is a necessary supplement to the other.

The great problem of university education is, in my opinion, so to correlate work in the two fields that each will be cultivated so as to promote good results in the other. The liberal training must not merely seek to satisfy general or even ideal conditions. It must aim to fit the student to play a creditable part in the affairs of after life, where he must work for a livelihood and for success. The vocational education must not be satisfied with the production of an efficient specialist. It must seek to produce as well a broadly educated and well rounded man.

The time is surely coming when our entire system of education will be based upon the idea which I have so inadequately presented, and that it is only when this idea is fully accepted and, as far as possible, realized in practice, that our school and university training, as a whole, will be so organized as to fit the needs of society.

I have spoken of education in the narrow sense of school and university training only to make clear what education is and its aims and purposes, as I understand them. Whatever views on the subject may be entertained (and I do not advance my own as either new or adequate) it is clear that the education of the individual is a matter not of a few years but of a lifetime. It begins with the first effort of will and intelligence and ends only when the faculties become so impaired that further development is impossible.

At the present time, practically all the people of European stock and, to a less degree, the more civilized races in other parts of the world have the benefit of school education. It is, however, no exaggeration to state that the bulk of the human race has had no such advantage. Comparatively few of all the men that have lived upon the earth have received any school instruction, and by far the greater part of the schooling that has been given was of a character largely useless and ineffective according to our modern standards.

And yet, what great things have been accomplished by those whose education was practically only that of individual experience, association with others and imitation! What great men have been developed without the aid of schools!

To go back to the earliest times of recorded history, we find in Assyria, Babylon and Egypt a real civilization in which for generation after generation, men of genius were developed and most extraordinary things done, said and recorded, although there is no reason to suppose that even in the most prosperous periods of those nations there was any definite education except among the priestly class, with whom it was chiefly an incident to their professional functions. Outside of their triumphs in war and conquest, the achievements of those ancient peoples in engineering, in architecture, in science, in law, in business, in literature and in art, fill us with amazement. Writing had been invented and the records that have come down to us on stone or burnt clay or papyrus show a condition of industrial, social and political development which is marvellous to the last degree. We find recorded elaborate codes of law; definite history with proper attention to chronology; philosophical and theological discussions; business documents of the most elaborate character; treaties and political proclamations. These records show a capacity for thought, intelligence and action practically equal, as far as one can see, to that of our own time. Not only were the simpler arts like agriculture and the textile

industries advanced to a point approximating that which had been reached a century or so ago, but architecture, engineering, sculpture and other fine arts, shipbuilding, navigation and astronomy had developed to a surprising extent.

The next race prominent in the world's history was the Greek, whose system of education confined as it was to a relatively few members of the community, has in it hardly a feature that commends itself to our modern practice. Gymnastics and music, the recitation of poetry and the study of the rudiments of mathematics studied not so much for the acquisition of knowledge as with the view of securing an harmonious physical, intellectual and æsthetic development, were the important elements in the education of the boy in the Golden Age of Greece. The utmost attention, however, was paid to insure his intimate association in affairs and full opportunity for personal contact with other men in all the important relations of life. We all know what the Greeks accomplished and to what extent the subsequent history of thought and intelligence has been based upon their work.

Next came the Romans, the great organizers and law-makers of the world. It cannot be said that their achievements, the influence of which has been to so large an extent a controlling factor in the history of the past 2,000 years, were based to any substantial degree upon their school education.

While the German races, who succeeded them, were not mere barbarian conquerors but had rules of law and standards of personal and national character and conduct which have influenced all subsequent development, it was probably many years after their settlement in Western Europe before any of them had such a thing as a school system.

Can it be said that school education was to any appreciable extent responsible for the great men and the great things of the Renaissance? I have often wished that some competent investigator would write a monograph on the education of Leonardo da Vinci, not merely to show what it was but to enable us clearly to determine what, if anything, there was in the training of his time that promoted or even allowed the development of so preëminent a genius. If the subject were properly studied and presented, much light might be thrown upon the problems of to-day.

One of the greatest of engineers, Leonardo invented the wheelbarrow and drained the Valley of the Po. He was an architect

and a builder of fortifications. He was a great sculptor, and it seems doubtful if any other painter who ever lived could have left to the world both the Last Supper in Milan and Mona Lisa now in the Louvre. Moreover, he was a literary man and an investigator and inventor of high rank.

If he were alone in his day, it would be easy to account for him as a genius, a *lusus naturæ* like Shakespeare, so far beyond the ordinary great man that no systematic education could have really helped or hurt. But there were many others of his time, both men and women, whose attainments were broad and varied to a degree almost as marked. Michael Angelo, for instance, is immortal as architect, engineer, sculptor, painter and poet.

It surely cannot be contended that school education has been essential to the development of great men or great periods in the world's history.

We have had in this country many examples of men educated to a high degree, who had none of the advantages of systematic training. No one can read the works of Benjamin Franklin without being impressed with the extent of his education and the completeness with which it fitted him to do great things. He, however, had practically no school facilities. Can anyone doubt that Lincoln was highly educated in the only sense which is of much moment? We all know contemporaries of our own who have received but little schooling but are soundly educated and even cultivated men.

I have called attention to the comparatively small part that systematic education has played in the development of great men and of great eras in the world and in the history and progress of our race not at all for the purpose of minimizing the importance of such education. The suggestion would be folly. The future prosperity of the human race and of every individual largely depends upon the extent and character of our educational facilities.

I only desire to emphasize what seems to me the necessity that every man should recognize that exactly as the Babylonians, the Greeks, the Romans, the men of the Renaissance and Benjamin Franklin were educated to an admirable degree so that they could be both "speakers of words" and "doers of deeds" without systematic schooling, so each one of us has the opportunity and the duty of supplementing the education that he gets in school and university by exactly the methods which have been so effective in times when systematic education, as we know it, was not available.

In the matter of education outside of school and university, much depends upon the individual and his point of view. It would be of great advantage to every man if he could understand from childhood how necessary it is for him to learn outside of his definite courses of instruction, and how important it is that he should make the effort necessary for this self-education. If he were from the beginning impressed with the idea that school and university are but episodes — of course of the greatest importance — in what is really a matter of a lifetime, this thought would surely shape his conduct and his attitude from the beginning. He would not only unconsciously and automatically receive instruction from the world. as do we all, but he would be on the lookout for such instruction, He would cultivate his powers of observation, and of judgment and reasoning from facts observed. He would interest himself in more of the fields of human thought and human aspiration. He would seek acquaintance with more subjects of general interest. He would analyze more carefully the character and action of the men with whom he came in contact. He would realize the importance of the constant study of his environment.

In all this effort he would find the greatest satisfaction. By it he would bring himself, to the extent of his ability and opportunity, into close touch with all forms of human aspiration and human activity, past and present, and thereby learn to understand men and the world to a greater degree than would be otherwise possible. He would be sure to be strengthened in the fundamental virtues of truth, loyalty, generosity, integrity, justice and charity, for no man whose touch with human life and human history is really sympathetic, can fail to recognize that these qualities are at the basis not only of society but of that personal adjustment to social conditions which is of such supreme importance to each individual. He would learn that nothing human should be otherwise than interesting to him. He would find pleasure in studying and observing every field of human effort.

Nor is there any reason why this idea, if it occurs with renewed force at the period of graduation from the university, should not be accepted as of vital importance and become fruitful. If I have made myself clear, I urge you, who have had the advantage of an admirable training in the Schools of Applied Science of this university, to take the thought to heart and determine whether you cannot develop it for yourselves to such an extent as to add essen-

tially to your value to the community and to your own satisfaction in your work and in your career.

While every man is in a position to utilize the educational opportunities of after life to the greatest extent possible to him, within the limits imposed by his character and capacity, it is the university graduate who should be best fitted to profit by such after education. If he has done his duty in the university, his powers of observation are so trained that it is easy and natural for him to seek for and to absorb knowledge and ideas. He has learned to reason and to judge with accuracy. He takes real pleasure in intellectual effort. His imagination has been cultivated so that he is in a position to apprehend not only the things that are obvious but the other elements of a situation that are incapable of physical observation but which must be recognized in their true relations in order that the perspective may be right. More than other men, he ought to have an instinct for the truth and the power of reasoning from things seen to things not seen; from the facts of the present to the opportunities of the future.

It is sometimes said that the graduates of the schools of applied science, the engineers, the architects and the chemists of the world, while as a class excelling in industry, zeal, honesty, loyalty and many other of the fundamental virtues, are lacking in breadth of view and the capacity for dealing with large questions in a large way, exactly as it is said of the graduates of the academic colleges that they are wanting in accuracy, persistency and definiteness of purpose and of method. In so far as this criticism on graduates of schools of applied science has any foundation, the basis for it lies, I think, largely in the character of the work upon which for four or five years their attention has been concentrated. It is arduous work requiring such intense effort as to make it difficult to turn away from it to matters not directly germane. Outside lighter pursuits are neglected. It deals primarily with the difficult facts and laws of nature, and while every moment there is full opportunity for the exercise of the powers of the imagination, the students of applied science do not always recognize this fact or if they do recognize it, they are oppressed, as it were, by the seriousness of their effort to master the solid knowledge and methods of working which they know to be of first importance.

Moreover, this absorbing professional training is pursued with the definite interest and enthusiasm which is sure to characterize

the effort to fit one's self for the specific vocation to which one's life is to be largely devoted, and it is natural that other things should be neglected almost as a habit.

It is immaterial for our present purpose whether or not there is any foundation for this friendly criticism as to the effect of a university education in applied science, acquired according to the best methods of instruction known at the present time. If it involves a narrowing influence, even to a slight degree, all the more is it necessary that the graduate of the university school of applied science should recognize the importance of definite self-education throughout his subsequent career. He will not remain stationary. He is sure to develop in some ways and in some directions throughout his active life. It is for him to determine the character and lines of his development and, very largely, its extent. The sole responsibility is upon him and he can at the most only be aided by a consideration of the views of others. He must think for himself. But some things are very clear and others may be advanced as suggestions.

First of all, the graduate who has the right ambition for real success must never allow his attention to be so distracted from his vocation, whatever it may be, as to interfere with the doing of the actual work which comes to him, in the best possible way and with constantly increasing efficiency as his knowledge and power are enlarged by experience. Here, he must be sound and thorough. No amount of versatility in other things can excuse slackness or want of loyalty to the work and to the men for whom and with whom the work is done. These propositions are fundamental; but it is quite consistent with the most absolute fidelity to professional work to cultivate a large and varied interest in things outside of that work.

In fact, there can be no doubt that the professional work will be better done if other interests are recognized and pursued sanely and intelligently. New and difficult problems may arise at any time. Every piece of work that an engineer and chemist is called upon to do after he has passed through the preliminary stages of his active career is likely to involve elements or conditions that are new in his experience. He will not find them, in the exact form in which they are presented to him, in any of the books that he has studied. He will be much better able to deal with each case as it arises, if, in addition to his strictly professional knowl-

edge and experience, his faculties have been further trained by investigation and effort in other directions, to alertness, activity and soundness of reasoning and of judgment.

A knowledge of how to deal with men, in the various relations in which he meets them, is of vital consequence to the success of an engineer. This is a subject in which no courses are given in the university. It must be mastered in the school of life.

The importance of such knowledge is not always recognized by the graduate who is just starting into work. Many men have failed, and many more have been delayed in advancement to positions of profit and responsibility by incapacity in this regard.

One of the first lessons that the graduate of the school of applied science has to learn is that of discipline, which in modern industrial enterprises where everything is based upon organization, should be almost of a military character. He does not always realize that it is by learning to obey that one becomes qualified to command. He does not appreciate that methods of work and of organization are now standardized to an extraordinary degree and that many things which seem to him, in his ignorance, unwise or defective are really based upon the results of a vast experience and intelligent study resulting in the necessary compromises best adapted to produce results. Strict obedience and an enthusiastic submission to established rules and to the lines of the organization are prime requisites, the importance of which cannot be overstated When the graduate of the school of applied science has really mastered this lesson, he has gone a long way toward understanding the environment in which his life's work is to be carried on and to fit himself for advancement and responsibility.

He can act effectively and advantageously neither as a subordinate nor as an officer in the industrial army unless he understands men in general and the individual men above him, below him, and on the same plane with him, with whom he has to work. Practically no two of them are alike. While the better he knows them, the more he will appreciate their good qualities, he will always have to be on the lookout for their faults or eccentricities, and with these he will have to deal outwardly and in his own mind with justice and discretion and always with charity. Even if he thinks that he sees things to criticize in his superiors, he must not only know but feel that loyalty to them and to the organization with which he is connected is of fundamental importance. He must be ready and glad

to make sacrifices on all matters, except those of principle, to work with the greatest harmony and efficiency side by side with those who are of equal rank. He must not merely give orders to his subordinates, but must learn that to get out of them the best that each can give, he should gain their respect and if possible their esteem. In dealing with others outside of his organization, there is required the same capacity for adaptation, involving a recognition of the real character and motives and an application of the same virtues of justice, discretion and charity.

Another thing that the wise man learns and more often practices in after life than in the university is the right kind of modesty and self-distrust. This is a merit only when accompanied by firmness self-respect, definiteness of purpose and strength and promptness of thought and action; but the value of these latter qualities is greatly increased if coupled with them there is always a sane hesitation as to the accuracy of one's thought and action, which results in an effort to get light and assistance from every source and to neglect no precaution before the conclusion is reached or the step taken which is irrevocable.

If, as seems certain, education in all directions is helpful in fitting one to deal with men and affairs, a constant recognition of this fact during the whole course of a professional career will lead to a fruitful effort to take advantage of every incidental opportunity to enlarge such an education.

But in addition to what comes from observation and experience, is it not also clear that in understanding men and in acquiring the ability to work with them on right lines, the graduate of the university school of applied science and all other men will be substantially aided by as great an acquaintance as possible with the recorded experience of others; with the thought, aspirations and achievements of the human race as a whole? From the earliest times we find that man has shown the same combination of good and bad qualities that he shows to-day. He has been actuated by substantially the same motives; the problems of life have been largely the same; and while his standards, moral, material and intellectual, have varied from time to time, the same underlying principles of life and conduct that we recognize to-day have, to a large extent, always prevailed.

Moreover, there is no profession so narrow and self-contained that it is not influenced by the general tendencies of our time in

all directions. No man who is really grappling with his work and striving to master it is doing his full duty unless he gives some thought to the moral, social, political, literary and æsthetic movements which are influencing and shaping the character and history of the times. These cannot, as a rule, be understood and their true meaning and probable future determined except in the light of the history which has led up to them and from which they have evolved.

An intelligent and sympathetic acquaintance with what have been and are the thoughts and aspirations of the race, as well as an appreciation of how those thoughts and aspirations have been and are developed in action and in conduct, is obviously of the greatest possible assistance in understanding and dealing with men. A study of them is almost a necessary supplementary training for professional work.

If I am right in this view, it should be the definite aim of every graduate from a university in continuing his education throughout his life to devote such portion of his time as he can consistently with his other duties, to the sympathetic study of human effort and endeavor and of human thought in other times as well as his own and in other fields than that in which he is working. No man who is active in the affairs of life has the time to go far with such study but everyone can accomplish something in this direction if he recognizes that it is a desirable and profitable thing for him to do.

It does not seem to me to make much difference in which field of the many that are open such work is done. Each man should find out and work in those that are most attractive to him. He may work in one field after another or in several at the same time, if it is more agreeable to him, without sacrificing the advantage which he seeks. This is not a case where the same thoroughness is required as in the main work of a man's life. He is here seeking not so much for accurate and complete knowledge as to quicken his apprehension and stimulate his imagination by learning what men have thought, dreamed, said and done.

Whether it is history or philosophy or poetry or literature or sociology or pure science to which attention is given, the time devoted will be well spent. Some men, but not many, can spend their spare hours pleasantly or profitably in studying Kant and Plato; every man can enjoy and profit by Shakespeare and Keats.

If one's taste does not lie in the direction of political history, he can get equal advantage from the study of industrial progress. If he finds that modern social or political discussions are unattractive, he may get his pleasure and profit from a consideration of the questions of education that are pressing upon us. If he finds music incomprehensible, let him try to become interested in architecture or painting. If he is repelled by Herbert Spencer, he may get full benefit from Lord Cromer's volumes on modern Egypt. If he is not interested in botany, he may find what he needs in folklore or archæology. If he does not care for the history of science, he may get great profit and satisfaction from pure literature and the study of its development. Every man should surely have some outside interest, and he is fortunate indeed if he is attracted by every field of human expression.

Such non-professional interests, properly pursued so as not to interfere with professional work, will not only promote general capacity and aid in sound moral and intellectual development but, in many cases, they will add to a man's efficiency in his own specialty. Can there be any doubt that an engineer who has studied the architecture of Egypt, Greece, Rome or of the middle ages will become more accomplished in his work? Is it not certain that the imagination of the chemist or of the electrician will be quickened by the study of other arts than his own, and even of pure literature, so that he will find his capacity for investigation and original thought distinctly improved? Will not a designer of machinery be aided in his every-day work by a knowledge of the principles of the fine arts and of the exquisite forms in which those principles have been expressed by the great artists?

It is a fundamental proposition that all the arts and sciences are related and that a study of one helps in the practice of another. Is it not equally true that every field of human thought and effort is related to every other and that within the limits of fidelity to his own work, no man can fail to gain in efficiency with every increase in his familiarity with what other men have been and are doing and thinking?

Thus far I have spoken of self-education chiefly as a matter of advantage to the graduate of a university school of applied science in building up his character and adding to his efficiency. But there is another side of the matter to be considered. Each man should earnestly seek for all the real pleasure he can get in the

world, and nowhere can he find it to a greater degree than in the study, however superficial, of nature and its manifestations and of human thought and action and what has followed from them. Mere work without recreation is killing to the body and spirit. Physical exercise and out-of-door sports are a source of enjoyment to many and are of advantage to all, but they are not congenial to all ages and all temperaments and are not of themselves enough. With most of us the mind needs to be rested and restored by active work in other than its ordinary lines of effort; and most of us can easily find some or many subjects of surpassing intellectual interest upon which to spend part of our time.

If I am right in my belief that almost any study, outside of his work, adds to the efficiency of the professional man and helps him in his chosen career, he is quite justified in definitely seeking to make this outside effort a relaxation and a pastime by selecting that which is of most interest to him. If he knows none such, let him try one after another until he finds what he wants. Having found it, he may have for all his life, in prosperity and adversity, an unfailing resource. He will know where to go for rest and cheer and comfort. The more such resources one has, the better; for the life even of the happiest and most successful is sure to have its periods of disappointment aud anxiety in which one needs intellectual relaxation both as a sedative and as a stimulant.

It is not to be forgotten that by the slight effort necessary to overcome the preliminary difficulties arising out of unfamiliarity, almost any field of intellectual or imaginative expression becomes attractive. This is particularly true of music and the fine arts which certainly should attract the systematically educated man of our day, as they have attracted all classes, even those which have had no schooling, in so many great periods of the world's history. Some fail to appreciate great music, and yet almost every one would get pleasure and exhilaration from it, if he would simply take the trouble to hear enough of it to enable his faculties to come into harmony with its form and expression. It is greatly to be deplored that any one should fail to apprehend as a personal delight the beauty of the Parthenon and the great cathedrals, or the pictures of the great masters, the study of which is sure to be a refreshing pastime to a cultivated man, if he once finds out how to approach that study with intelligence. The wonderful concerts that are given in such large numbers in all our great cities every

year afford full opportunity for the training in music. Museums and galleries are accessible to most of us. Our public libraries are filled with books on the fine arts, and nearly every man can well afford to have some such books of his own.

Art and material things have become too far separated in our thoughts as well as in our practice of to-day. In substance they are closely united and the time will surely come in the future when, as in many periods of the past, the community at large will sympathize keenly with artistic expression and value it as on an equal plane with structural excellence.

Rudyard Kipling has recently written a poem in his characteristic style on the eternal "strife" and "hate" and "feud" between Jubal, "the father of all such as handle the harp and organ," and Tubal Cain, the "instructor of every artificer in brass and iron." This is a strange doctrine for the man who wrote "McAndrews' Hymn," "The King," "The Ship That Found Herself," and "Engine 007," with the definite purpose of showing how our modern industrial life is permeated with artistic and idealistic concepts. His former doctrine may have been an exaggeration, but there is no truth whatever in his picture of an earth-long conflict between Jubal and Tubal Cain. Brothers they were by birth, the offspring of human need and human aspiration. Brothers they will remain until the end of time. It may be that they and their children do not now for a brief moment have the close relation which is natural and even necessary, but the happiness of the whole race is intimately related to the permanence of the tie which binds them in cordial harmony as types of the artistic and material.

The question may well be asked — Is there time for this self-education after graduation from the university? The work of the vocation is strenuous and must not under any circumstances be interfered with. It takes many hours out of the day. There must be time for sleep, for physical exercise, for amusement and for social relations. A professional man has to adjust his life to all these requirements.

It must not be forgotten that part of the education which I believe should be definitely and consciously continued throughout life comes as an incident to each and all of the other activities. It merely involves intelligent observation and thought as one is busy with his other affairs. No special time is required for this form of continuous education.

For the more systematic study of the interesting phases of nature and of life, past and present, which I so strongly urge, some time is surely required but not necessarily a large amount. Much can be accomplished if a few hours a week are given to such subjects, and no one can doubt that some hours can easily be spared for them. We do not always realize how much time we waste, not merely in doing nothing but in matters that are really neither pleasant nor profitable to us. We must all read the newspapers that we may keep in touch with the events and current discussions of the day; but have not some a definite newspaper habit which kills time that might be much better spent in other ways? Is there not more theater-going than a sane man can justify in view of the present condition of dramatic art? Is not much time wasted on the innumerable magazines and weekly publications that could be otherwise better and more pleasantly employed? Is it worth while to wade through much of the modern fiction which is manufactured and read in such quantities that it almost seems as if most of us must be devoting our lives to its perusal? A proper amount of attention may well be given to all these devourers of time, if they are a source of satisfaction, but too much should not be sacrificed to them.

Social engagements, casual conversation and ordinary current amusements are delightful and profitable. Every man should participate in them in his own interest and to promote and enlarge those friendly relations upon which so much of the joy of life depends. But devotion even to these may be carried to an extreme, so as to weary and disturb rather than to refresh and invigorate. While they should never be neglected, it is not at all impossible that sometimes one's feeling of social duty to himself and to others carries him beyond the point of mutual satisfaction, resulting in a real waste of time that might otherwise be better employed.

Almost all of us spend hours in the steam and street cars. Many of us have found here a large opportunity for reading and for study. We have learned to carry with us as a regular part of our travelling equipment, if the journey is to be a long one, not one book but several, each dealing with a different subject, that we may to some extent gratify the particular mood in which we may happen to find ourselves. We cannot carry a library in the street cars, but what would otherwise be a disagreeable morning and evening trip may be transformed into a pleasant excursion if

we take advantage of the opportunity to read one of the great English magazines or a book of real value in which we are interested. Much more may be accomplished within the limits of the opportunities open to us than is generally realized.

If I am right in believing that a man's work is better done and that he becomes a more useful citizen and gets far more satisfaction out of life, if he makes a definite effort to take full advantage of the delightful educational opportunities which are within his own control, it is certainly well worth while for every man and particularly every graduate of a university to consider what he may accomplish in this direction, with the view of enlarging his horizon, increasing his capacity for work and pleasure, developing his moral and intellectual faculties, and in general fitting himself to play a larger and more creditable part in the affairs of life.

I do not overlook the fact that some men have no spare time. Many have special private duties which limit their opportunity for definite effort of the kind to which I have referred. Some are unselfishly engaged in promoting the public interest in politics, reform movements and in the works of culture, education or charity. Great is the obligation of the community to such men. Many of us, however, have the time, if we elect to utilize it. It is upon this large majority that I urge a definite recognition of the advantages and pleasure to be derived from the lifelong opportunities for continuous education which are open to us all.

KINEMATICS OF ONE FORM OF ROTARY PUMP OR BLOWER.

By SAMUEL W. BALCH.

The purpose of this article is to set forth some elements in the design of one of the earliest forms of rotary pump or blower adequate treatment of which the writer has not been able to find in mechanical literature. Briefly described, in the type here under consideration, there is a cylindrical drum or block mounted to revolve on its axis in an eccentric position within a casing so as to form therewith a crescent-shaped chamber. Blades mounted to slide diametrically in the drum form traveling partition walls or pistons in the chamber.

A peculiar shape is required for the enclosing casing. It must have a curve in which all chords passing through the center of the drum have the same length. The curve must be slightly oval but it cannot be a true ellipse. There are innumerable curves having

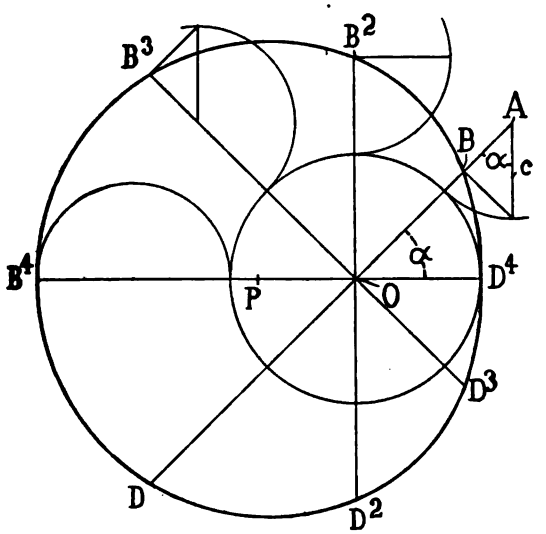


FIG. 1.

the required property, but there is a particular curve which will afford the smoothest action and which will in the case of crossed blades maintain the parts in the same balance. This is the curve

which, if the drum is revolved uniformly, will reciprocate the blades across the drum in the same way that a steam-engine piston reciprocates under the control of a uniformly revolving crank, barring irregularities caused by the obliquity of the connecting rod.

Two methods of constructing the curve are here shown. Referring to Fig. 1, any point B of the curve may be found by drawing a line OA from the center of the drum at any angle α, making OA equal to half the width of the curve, which will be denoted by b. At A a circle is drawn with a radius c equal to the distance between the middle point P of the curve and the center of the drum. Set off AB equal to $c \cos \alpha$. Denoting by variable r the radius of the curve at variable angle α, then

$$r = b - c \cos \alpha$$

may be written as the polar quotation of the curve. The sign will be plus instead of minus if the angle is measured from OB^2 instead of from OD^4. The curve is a familiar one in mechanics, for it represents the shape of a cam which will impart a reciprocating movement corresponding to the movement given by a crank.

The curve has some interesting properties in connection with the rotary which will be apparent, if instead, it is constructed as indicated in Fig. 2, the result, as will be shown, being the same. In this diagram a circle is drawn with the distance c between the center of the drum and the middle of the curve as a diameter. To find a point of the curve at any angle α, a radius to the circle CA is drawn at an angle 2α. Then AB is drawn at the angle α equal to b. The line or its prolongation will necessarily pass through the fixed point O in the circumference of the circle, and OA will equal $c \cos \alpha$. The line OB is, therefore, $AB - OA$ equal to $b - c \cos \alpha$, the same as was deduced from the construction of the first diagram. Hence the curve is the same. It has been called a per-trochoid and also a cardioid. The aptness of the latter name may be shown by drawing the curve about a somewhat larger circle as a nucleus without increasing the length of the line b. Then at the point D^4 where it is flattest it will become indented and the resemblance to a heart will be apparent. For convenience of illustration and to make the peculiarities of the curve more apparent, it has been made more eccentric in the diagram s than is admissible in a rotary.

The middle point A of either blade travels in a circle as the

mechanism revolves, and, since it is advanced angularly in the circumference by twice the angle of the blade BD, it follows that the middle point of a blade makes two revolutions to one of the blade and drum. As the second blade $B'D'$ is 90 degrees re-

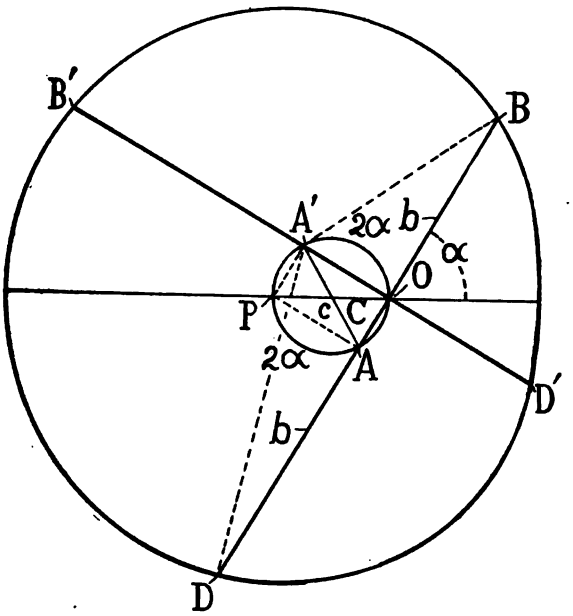


FIG. 2.

moved, its middle point A' is 180 degrees removed. As A and A' are the centers of gravity respectively of the blades BD and $B'D'$, the two blades, if of equal mass must remain in balance about the center of the circle C. Centrifugal forces like gravitational torques also vary as their lever arms, and hence are also equal and opposed on opposite sides of the center C. Energy, which varies as the square of the velocity, and hence as the square or the lever arm, is not balanced in the same way, and there is a constant shifting of the center of percussion of the blades taken together.

From the foregoing it will be seen that a shaft may be mounted at C with cranks engaging the middle points of the blades and employed in power transmission if desired. Such a shaft will have double the speed of the blades, and may be directly coupled to a standard electric motor, the speed of which is usually about twice that practicable for a rotary. As the casing is not required to

cam the blades to and fro with such a construction, more eccentricity is admissible and the capacity can be fifty per cent. greater. The friction of the blades due to centrifugal action will then be removed from the casing to the crank-pins where surface movement is slower. This construction requires especially accurate workmanship.

An interesting peculiarity of the curve, useful in drawing it approximately with arcs of circles, should be noted (Fig. 2). Lines BA' and DA' from the ends of either blade to the middle point of the other blade are always at right angles to the curve at the points where they touch, and the centers of curvature will lie on these lines.

It will also be seen that a line AP at right angles to the blade at its middle point passes through the point P in all positions of the blade. From this it follows that a blade may also be controlled independently of the casing by providing it with a transverse slot on the line AP and engaging the slot by a pin fixed at P. This is practicable in a rotary with a single through blade, but with balanced crossed blades it is not easy to avoid interferences.

Speed limitation in a properly balanced rotary arises chiefly from the throwing out of oil by the centrifugal action, thereby requiring efficient lubrication and means in the discharge for the recovery of the oil. This being properly cared for, the rotary has the advantage over the reciprocating pump of compactness and capacity. Since fan blowers operate only under pressure differences of a few ounces, the rotary has the advantage over these where several pounds pressure difference is to be maintained. For operation with an expansive fluid between fairly constant pressures, the ratio between which does not exceed five or six, the rotary can be designed to compress with maximum efficiency by properly locating the ports so that the passage of the blades will release at the required compression, no valve gearing being necessary.

The rotary here illustrated is designed to release on the high pressure side when the blade is at 45 degrees. On the low pressure side the cut off should always be at 135 degrees to develop full capacity. The volume ratios and the inverse absolute pressure ratios for air at different angles of release are given in the following table.

Angle.	$\frac{V}{V'}$	$\frac{P'}{P}$	Angle.	$\frac{V}{V'}$	$\frac{P'}{P}$
15	3.85	6.60	30	2.70	4.03
16	3.75	6.36	35	2.41	3.45
17	3.63	6.14	40	2.20	3.02
18	3.54	5.91	45	2.01	2.67
19	3.45	5.70	50	1.86	2.39
20	3.37	5.50	60	1.60	1.94
22	3.21	5.13	75	1.33	1.51
24	3.07	4.83	90	1.16	1.26
26	2.94	4.56	135	1.00	1.00
28	2.82	4.30			

Higher pressure ratios than are here given can be taken care of by valve gearing or by compounding.

When used either as a vacuum or pressure pump and the pressure ratio is liable to rise above that for which the pump is designed

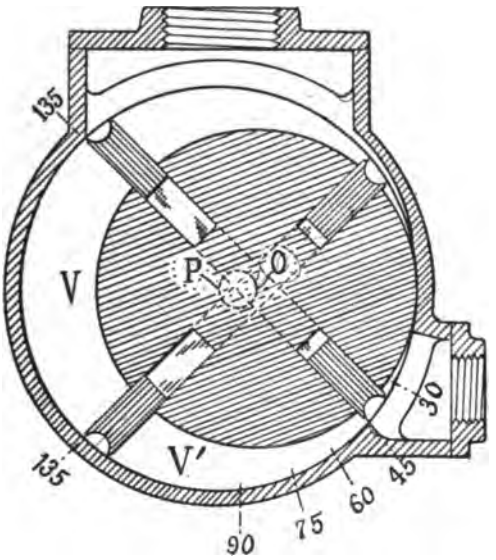


FIG. 3.

and the higher ratio is not useful, a relief valve is an economical addition, and relieves the mechanism from unnecessary strain. In the case of a vacuum pump this valve would be inserted on the low pressure side and operate to reduce the difference by raising the pressure, while in the case of a pressure pump it would be inserted on the high pressure side and operate to reduce the difference by relieving the pressure.

Among the many and varied types of rotaries, excepting those with duplicate compression chambers and mechanism, this type alone appears to have the merit of exact balance, thereby permitting high speed. In capacity per revolution as well it is equal or better in comparison with other types, even where the advantage may not at first be apparent, as for example, where the chamber is annular and of greater volume than the crescent chamber, outside dimensions being the same, for it is to be noted that the crescent-shaped chamber is not the measure of capacity per revolution as are the chambers of other types, the measure instead being the largest quadrant V four times repeated.

A note as to the history of this type may be of interest. With a single through blade it dates back 250 years to Buonaventura Cavallerio at Bologna University. With a pair of blades notched and crossed as shown in Fig. 3, it was invented by Ferdinand J. Rochow in 1861, then just arrived in New York. Hard put for something to do, he drafted it at his lodging place on a piece of wrapping paper. It has now been manufactured for nearly fifty years, and in its application as a pump for water no modification of his original design worthy of adoption has been found. Mr. Rochow is still active as an inventor, his last invention being for a car in which live fish are brought to New York from inland lakes. His rotary pumps are employed for water circulation and for aëration on the car. It is safe to say that not many inventors have a meritorious output covering so long a term.

THE DEFLECTION POLYGON OF A FRAMED STRUCTURE AS A FUNICULAR POLYGON.

By MYRON S. FALK, Ph.D.

Any connected series of lines such as $1 \cdot 2 \cdot 3 \cdot 4 \ldots$ (Fig. 1) may be regarded as a funicular polygon for definite forces $P_1 \cdot P_2 \cdot P_3 \ldots$ and these forces may be assumed to act in any direction through the corners or angles of the polygon.

The ordinary deflection polygon for a framed structure, such as the polygon showing the vertical displacements of the lower chord of a through bridge, may consequently be considered to be a funicular polygon for assumed vertical forces acting at the lower chord panel points. In order to draw this deflection polygon as a funicular polygon, it is only necessary to evaluate these forces.

Properties of the Funicular Polygon.

A simple relation may be found to exist between the forces P of a funicular polygon and the sides or rays of the polygon, provided the forces P are parallel to one another; this condition exists in the case of the deflection polygon, in which the assumed forces may be taken vertical.

Let $P_1 \cdot P_2 \cdot P_3 \cdot P_4$, Fig. 1, represent vertical forces acting at the points of intersection of the rays 1, 2, 3, 4, ... of the funicular polygon $1 \cdot 2 \cdot 3 \cdot 4 \ldots$.

Continue ray 2 through a to its intersection at d with a vertical through c, the line of action of P_3.

Draw ab parallel to the closing line AB of the polygon; let $x_2, x_3, \ldots$ represent the projections of the rays 2, 3, ... upon a horizontal line, and let $y_2, y_3, \ldots$ represent the intercepts between the funicular polygon and the closing line.

From similarity of triangles:

$$\frac{bd}{y_2 - y_1} = \frac{x_3}{x_2}.$$

Since $bc = y_3 - y_2$

$$cd = bd - bc = \frac{x_3(y_2 - y_1)}{x_2} - (y_3 - y_2). \qquad (1)$$

Fig. 2 represents the force polygon corresponding to the funicular

polygon, and shows the rays 1, 2, 3, 4, ... drawn from the pole O; H represents the pole distance.

From similarity of triangles in Figs. 1 and 2,

$$\frac{cd}{x_3} = \frac{P_2}{H} \quad \text{or} \quad cd = \frac{P_2 \cdot x_3}{H}.$$

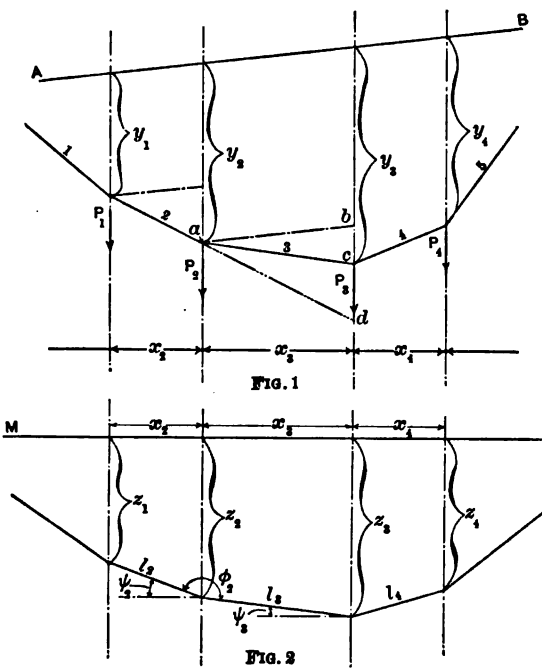


FIG. 1

FIG. 2

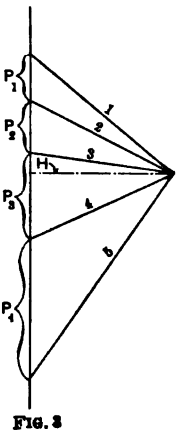


FIG. 3

Substituting this value in Eq. 1, there is obtained

$$P_2 = H\left[\frac{(y_2 - y_1)}{x_2} - \frac{(y_3 - y_2)}{x_3}\right],$$

or in general

$$P_m = H\left[\frac{(y_m - y_{m-1})}{x_m} - \frac{(y_{m+1} - y_m)}{x_{m+1}}\right]. \qquad (2)$$

P_m represents the imaginary force acting at the panel point m, which, in connection with other similar forces at other panel points, will enable the funicular polygon to be drawn. It is necessary to express the right hand member of Eq. (2) in known units.

The Deflection Polygon.

Let the lines l_2 $l_3 \cdot l_4 \ldots$ in Fig. 2 represent the chord members of any truss, for which it is desired to find the deflection polygon as shown in Fig. 1. The length of each chord member is represented by l with the proper subscript and its projection upon a horizontal line MN by x; the vertical distance of each panel point from the line MN is represented by z; the angle between any member l and the horizontal is represented by ψ, and the angle between any two members by ϕ.

The following relation exists between these angles:

$$\varphi_2 = \psi_3 + 180° - \psi_2,$$

or in general

$$\varphi_m = \psi_{m+1} + 180° - \psi_m,$$

and by differentiating

$$\Delta\varphi_m = \Delta\psi_{m+1} - \Delta\psi_m. \tag{3}$$

From Fig. 3:

$$z_3 - z_2 = l_3 \cdot \sin \psi_3.$$

Differentiating

$$\Delta z_3 - \Delta z_2 = \Delta l_3 \cdot \sin\psi_3 + l_3 \cdot \cos \psi_3 \cdot \Delta\psi_3. \tag{4}$$

Dividing by

$$x_3 = l_3 \cdot \cos \psi_3,$$

$$\frac{\Delta z_3 - \Delta z_2}{x_3} = \frac{\Delta l_3}{l_3} \cdot \tan \psi_3 + \Delta\psi_3, \tag{5}$$

or in general

$$\frac{\Delta z_{m+1} - \Delta z_m}{x_{m+1}} = \frac{\Delta l_{m+1}}{l_{m+1}} \cdot \tan \psi_{m+1} + \Delta_m\psi_{+1} \tag{6}$$

and

$$\frac{\Delta z_m - \Delta z_{m-1}}{x_m} = \frac{\Delta l_m}{l_m} \cdot \tan \psi_m + \Delta\psi_m. \tag{7}$$

The quantities Δz of Eqs. 6 and 7 are the vertical displacements of the panel points, and are precisely the quantities y of Eq. 2. and may be substituted for them; consequently

$$P_m = H\left[\frac{\Delta l_m}{l_m} \cdot \tan \psi_m - \frac{\Delta l_{m+1}}{l_{m+1}} \cdot \tan \psi_{m+1} - (\Delta\psi_{m+1} - \Delta\psi_m)\right]. \tag{8}$$

Substituting also in this equation the value of $\Delta\phi_m$ as found in Eq. 3, there is obtained

$$P_m = H\left[\frac{\Delta l_m}{l_m} \cdot \tan \psi_m - \frac{\Delta l_{m+1}}{l_{m+1}} \tan \psi_{m+1} - \Delta \varphi_m\right]. \qquad (9)$$

It is evident that P_m can be expressed in known units provided ψ is not a right angle; in the application of this method, it is therefore necessary that no chord member be vertical.

The equation

$$E = \frac{p \cdot l}{\Delta l}$$

expresses the value of the coefficient of elasticity E in terms of unit stress p, length of member l and change of length Δl; that is, $\Delta l / l = p/E$. Substituting this value in Eq. 9

$$P_m = H\left[\frac{p_m \cdot \tan \psi_m}{E} - \frac{p_{m+1} \cdot \tan \psi_{m+1}}{E} - \Delta \varphi_m\right]. \qquad (10)$$

If the chord should be horizontal, all the angles ψ would be zero, and Eq. 10 would appear as

$$P_m = -H \cdot \Delta \varphi_m. \qquad (11)$$

If the pole distance H be taken equal to the coefficient of elasticity E, then Eq. 11 will take the form

$$P_m = -E \cdot \Delta \varphi_m. \qquad (12)$$

and the determination of the quantities P_m is easily found, by the aid of Eq. 19 of a previous article.*

EXAMPLE.

The preceding method may be applied to the truss† shown in Fig. 4; the span length is 240 feet, and the other dimensions are shown in the figure. The unit stresses p and the changes of length Δl are also indicated for each member. The end a is the fixed end and the point i moves on a horizontal roller bed. E is assumed to be 28,000,000 pounds per square inch.

The quantities $E \cdot \Delta \varphi_{abj}$, $E \cdot \Delta \varphi_{jbc}$, etc., are shown in Fig. 5 written within the respective angles; they were found by the aid of the general equation

* "Displacement Diagrams of Framed Structures by Deflection Angles." SCHOOL OF MINES QUARTERLY, Vol. XXIX., No. 3.

†The deflections of this truss by the method employing the Williott diagram are given in Burr & Falk's "Influence Lines," p. 168; by the method of deflection angles, SCHOOL OF MINES QUARTERLY, Vol. XXIX., No. 3, April, 1908.

$$E.\Delta\varphi_c = (p_3 - p_2)\cot\varphi_a + (p_3 - p_1)\cot\varphi_b.$$

The total change of angle at each lower chord panel point is found by the summation of the individual changes, and they are shown in Fig. 5 as $E\cdot\Delta\varphi_b$, $E\cdot\Delta\varphi_c$, etc., below the respective panel points. These quantities, according to Eq. 12 are the forces for which the funicular polygon is to be drawn; they are laid down to scale (as pounds per square inch) in Fig. 7. It was found convenient to adopt the scale in this figure so that the pole distance

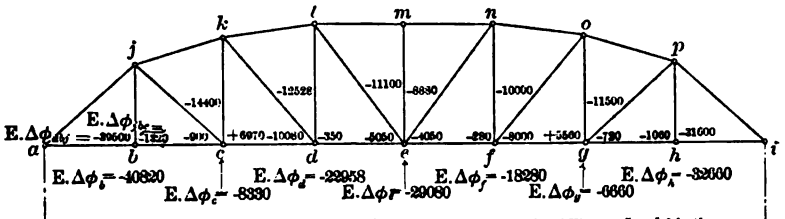
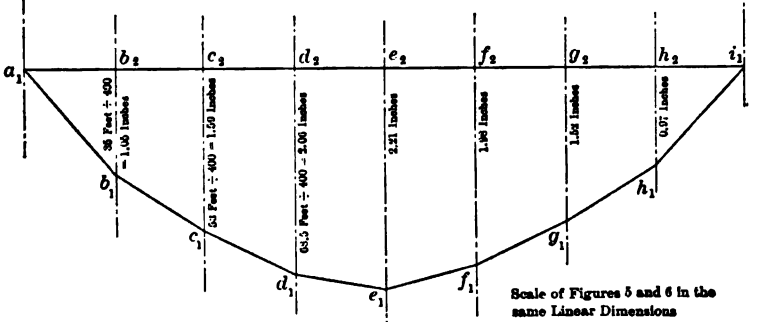


FIG. 5. Scale of Figures 5 and 6 in the same Linear Dimensions



Scale of Figures 5 and 6 in the same Linear Dimensions

FIG. 6.

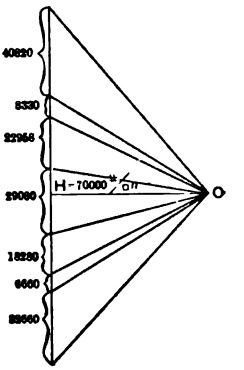


FIG. 7

H was 70,000 pounds per square inch; the scale of the truss (Fig. 5) in the original diagram was one inch equal to 30 feet; the dimensions of the deflection polygon (Fig. 6) are then to be measured in this same scale (1 inch equals 30 feet) but must then be divided by 28,000,000/70,000 = 400, because the pole distance was taken by scale at 70,000 instead of 28,000,000.

The funicular polygon a_1, b_1, c_1, d_1, etc., is drawn in the usual manner, and since neither of the points a nor i suffers vertical displacement, the closing line $a_1 i_1$ may be drawn at once connecting the two end points of the figure.

The deflections of the lower chord panel point b is then $b_1 b_2$; it scales as 35 feet in Fig. 6; dividing by 400, its actual displacement is found to be 1.05 inches. The other lower panel point displacements are found in the same way; since in this problem, the upper panel points are connected by vertical members to the lower, their displacements may be found directly from the latter by adding or subtracting the change in length of the connecting vertical.

HYDRAULIC DIAGRAMS.

By S. D. BLEICH.

This paper has for its object the presentation of such data and diagrams as will facilitate hydraulic computations. It is not critical nor are any new formulas or methods devised. Only the most widely recognized formulas are used and elaborated. Two diagrams for runoff, and two for flow in circular conduits are given. These are based respectively on McMath's formula, the New York diagrams, Chezy's formula with Kutter's modification and Hazen-William's formula. These diagrams are fully explained and such additional information is given as to increase their usefulness.

The advantages of diagrams over tables are many. They are more compact; they present the interrelation of the factors at a glance; interpolation is more quickly effected; and they are economical in time and labor. Complete tables usually comprise a good-sized volume, whereas the same scope as the tables may be presented in a single diagram. The effect of a change of one of the factors entering the problem, on the remaining factors, does not by the use of tables become immediately evident, whereas a diagram will reveal this effect instantaneously. By the use of tables interpolation involves a complicated mental operation of a subtraction and a proportion; in a diagram interpolation is performed graphically. Although it is true that more accuracy is secured with the use of tables, it is of little moment, because a diagram will give results as accurately as the conditions of the problem usually warrant.

It will be noticed that all the diagrams are given on logarithmic cross-section. This was done to take advantage of the exponential character of all the formulas. In working up the diagrams the labor of computation and plotting becomes thereby very much reduced and simplified, due to the appearance of straight lines instead of curves. The other advantages of logarithmic cross-section ruling are the large range it affords in a relatively small space, and the harmonious proportion it maintains among the quantities. It gives the necessary detail among the smaller quantities and omits it among the large quantities where it is unnecessary. This

is accomplished by having the quantities increase geometrically as the coördinate distances increase arithmetically.

Run-Off Formulas.

A systematic method or a rational formula for the determination of the maximum amount of storm water which will reach a conduit or sewer still remains to be desired. Due to the mist which surrounds this subject a great variety of formulas for runoff are in current use. In consequence, the results which are obtained by any one method is accompanied with an uncertainity, which can be only partly allayed when the results are checked by some of the other methods. The best recognized of the empirical formulas are McMath's and the New York, and the diagrams for these are given. Both of these diagrams are constructed in the same way. They solve graphically the expression

$$\frac{Q}{CR} = A^x S^y;$$

x and y in McMath's formula, are respectively equal to $\frac{4}{5}$ and $\frac{1}{5}$; and in the New York formula to $\frac{5}{6}$ and 0.27; A represents the drainage area in acres; S, the slope in feet per 1,000 feet; Q, the runoff in cubic feet per second; C, the ratio of imperviousness, and R the factor for the maximum rainfall intensity in inches per hour.

The drainage area A can be obtained from a map drawn to a suitable scale by a planimeter or by actual computation. The slope S can be either made to represent the general slope of the ground surface or of the sewers. The ratio of the imperviousness C must be approximated from a knowledge of the character of the drainage area; some measurements may be taken to determine the area and the character of the pavement; the area of lawns, gardens and parks, and the area occupied by houses. C may vary from 90 per cent. to 100 per cent. for some parts of Manhattan; for portions of Brooklyn it is about 75 per cent. and for suburban districts it may be 40 per cent. and less. The meaning of the factor R has been very frequently misunderstood. It does not represent an actual rainfall intensity for the drainage area, it is of the nature of a constant depending for its value on the maximum amount of rainfall for the district. It may have a value of three inches per hour for one district and perhaps four for another. The value of R when once determined, is used unchanged for small areas and large

areas, for flat and steep slopes; the variation of intensity of rainfall due to these conditions is taken care of by the formula itself.

McMath's Formula.

The use of the McMath diagram (Plate 1) is simple. Given the drainage area in acres and the general slope of the ground or sewers in per cent. the diagram solves at once the expression $A^{4/5}S^{1/5}$. Let $A = 234$ acres and $S = 2.5$ ft. per 1,000 or 0.25 per cent., then the itersection of these two coördinates is at 95 of an interpolated oblique line. To obtain the discharge in cubic feet per second it is necessary to multiply this value for $A^{4/5}S^{1/5}$ by CR, which is generally a constant. The Brooklyn sewers are designed by McMath's formula with $C = 0.75$ and $R = 3$ inches per hour. Using these values for CR we obtain for the runoff from 234 acres having a general slope 0.25 per cent. 95×2.25 or 214 cubic feet per second.

The following tabulation indicates the degree of accuracy which can be obtained by use of the diagram. The discrepancy between computed results and the results obtained from the diagram is negligible.

Acres.	Slope.	$A^{\frac{4}{5}}S^{\frac{1}{5}}$	
		Computed.	Diagram.
5	.02 per ft.	6.6	6.7
17	.015	16.6	16.5
85	.008	53.0	53.0
234	.0025	94.4	93.0
750	.001	199.6	200.0

New York Diagram.

The New York diagram (Plate 2) is used in precisely the same way as the McMath diagram. Let the drainage area A be 300 acres and the slope S, 1.75 ft. per 1,000 ft. or .175 per cent. grade, then the New York diagram solves the expression

$$A^{5/6}S^{0.27} = 300^{5/6} \times 1.75^{0.27} = 123.$$

If the ratio of imperviousness for this area is .50 and the factor for rainfall intensity 2.75 inches per hour, the runoff will be

$$Q = 0.5 \times 2.75 \times 123 = 169 \text{ cubic feet per second.}$$

A table giving a comparison of the results obtained by actual computation and those from the diagram is given.

Acres.	Slope.	$A^{\frac{1}{2}}S^{0.27}$	
		Computed.	Diagram.
5	.02 per ft.	8.6	8.6
17	.015	22.0	22.0
85	.008	71.1	71.0
234	.0025	120.7	120.0
750	.001	248.8	248.0

SIZES OF CONDUITS (PLATES 3 AND 4).

Having ascertained the amount of water reaching any sewer its size and grade can be readily obtained from either the diagram for Kutter's formula or for Hazen-William's formula. These diagrams are so arranged as to solve the expression $v = cr^m S^n$ and $Q = Av$ in which r is the velocity in feet per second; c is a factor depending for its value mainly on the physical condition of the conduit; r represents the mean hydraulic radius; S, the slope; Q, the discharge in cubic feet per second; and A the cross-sectional area in square feet. In the diagram for Kutter's modification of Chezy's formula m and n are $\frac{1}{2}$; and for Hazen-William's formula $m = .63$ and $n = .54$. A difference exists in the significance of c in the two formulas. In Kutter's modification (Plate 3) of Chezy's formula c is not a constant for any condition of pipe or material; but is dependent in a complicated manner on the mean hydraulic radius, the slope, in addition to a factor for roughness. In Hazen-William's formula the exponents m and n have been so chosen as to make c vary with the character of the material, only the mean hydraulic radius and the slope have no effect whatsoever on its value.

It will be noticed that both diagrams for sizes of pipe are constructed in the same manner. The coördinate lines give the grade in per cent. and the discharge in cubic feet per second; one set of oblique lines gives the diameter of the pipe to accommodate the discharge when flowing full; and the other set of oblique lines gives velocity in feet per second. A ratio diagram is added to the Kutter's diagram extending its usefulness for values of n, the coefficient of roughness, varying from .01 to .02. In the Hazen-William's diagram (Plate 4) a table is added giving the values of "c" for different materials. A few problems will be given to illustrate the use of these diagrams.

What is the discharge in a 7 ft. circular sewer having a 0.7 per cent. grade, flowing full, using Kutter's formula with $n = .015$?

At the intersection of the oblique diameter line marked 7 ft. and the vertical line of 0.7 per cent. grade, a velocity of 12 ft. per second and a discharge of about 470 cu. ft. per second are obtained.

In the above problem let $n = .017$; obtain the velocity and the discharge.

From the ratio diagram a ratio of 0.867 is obtained for a 7 ft. diameter. The velocity $= .867 \times 12 = 10.4$ ft. per second, and the discharge $= .867 \times 470 = 407.5$ cu. ft. per second.

Let $n = .011$; then the ratio is 1.4. The velocity $= 1.4 \times 12 = 17$ and the discharge $= 1.4 \times 470 = 660$ cu. ft. per second.

Given a discharge of 30 cu. ft. per second, a grade of 1.5 per cent.; and $n = .013$, obtain the size of pipe to accommodate the discharge when flowing full.

An approximate diameter of 2 ft. can be obtained for $n = .015$. The ratio for $n = .013$ and a diameter of 2 ft. gives a ratio of 1.2. As a smaller pipe is required for $n = .013$ than for $n = .015$, divide 30 by 1.2; the result is 25 cu. ft. per second. Now use the diagram with a discharge of 25 cu. ft. per second and a grade of 1.5 per cent. and a diameter of 2.1 ft. will be obtained. To obtain the velocity, use the actual discharge of 30 cu. ft. per second and the required diameter of 2.1 ft., and a velocity of 9 ft. per second is obtained.

The diagram for Hazen-William's formula (Plate 4) is used in the same manner as that for Kutter's. This diagram is based on a value of c equal to 100, and values of c for different kinds of material are given in the accompanying table. Judgment is required in the selection of the proper value of c.

It is required for example to find the size of a brick sewer flowing full for a discharge of 250 cu. ft. per second a grade of 0.55 per cent. In this case $c = 100$. The intersection of an interpolated line of 0.55 per cent. grade with a 250 discharge line gives a diameter of about 5 ft. 8 in., and a velocity of 9.8 ft. per second.

What is the size of a vitrified pipe for a discharge of 45 cu. ft. per second flowing full at an 0.8 per cent. grade? In this case $c = 110$. It is evident that a smaller size than the one obtained from the diagram for 45 cu. feet per second will suffice. Divide 45 by 110/100 and 41 will be obtained. Using 41 instead of 45 for the discharge in the diagram and a grade of 0.8 per cent., a diameter of 2.7 ft. and a velocity of 7.5 ft. per second will be obtained. The nearest commercial size of vitrified pipe, would, of course, be used. The velocity of 7.5 is to be multiplied by 1.1 as the real

discharge is 45 and not 41. The velocity will therefore be 8.25 ft. per second. The same velocity will be obtained directly from the diagram by using the actual discharge of 45 cu. ft. per second and the size required of 2.7 ft.

A 6 ft. circular masonry conduit of ordinary good work at a grade of 0.3 per cent. is to discharge into three cast-iron pipes at a grade of 0.4 per cent., two of which are to be of the same size; determine the sizes of the cast-iron pipes. For the masonry conduit $c = 120$, and for the cast-iron pipe $c = 130$. The discharge through the masonry conduit flowing full is $210 \times 1.2 = 252$ cu. ft. per second. The discharge through one 42 in. cast-iron pipe at a 0.4 per cent. grade is $60 \times 1.3 = 78$ cu. ft. per second; and through a 48 in. cast-iron pipe at the same grade the discharge is $83 \times 1.3 = 108$ cu. ft. per sccond. Therefore, two 42 in. pipes and one 48 in. will have a discharge of 264 cu. ft. per second. This combination of cast-iron pipes will more than take care of the flow from the masonry conduit.

Sections other than Circular.

The diagram for flow through circular pipes may be used for other sections, if the relation between them for the same discharge is known. All that is necessary is to enter the diagrams with the equivalent circular sections. The following relations exist between the standard egg-shaped section having a width equal to two thirds of the height and the circular section for the same discharge when flowing full,

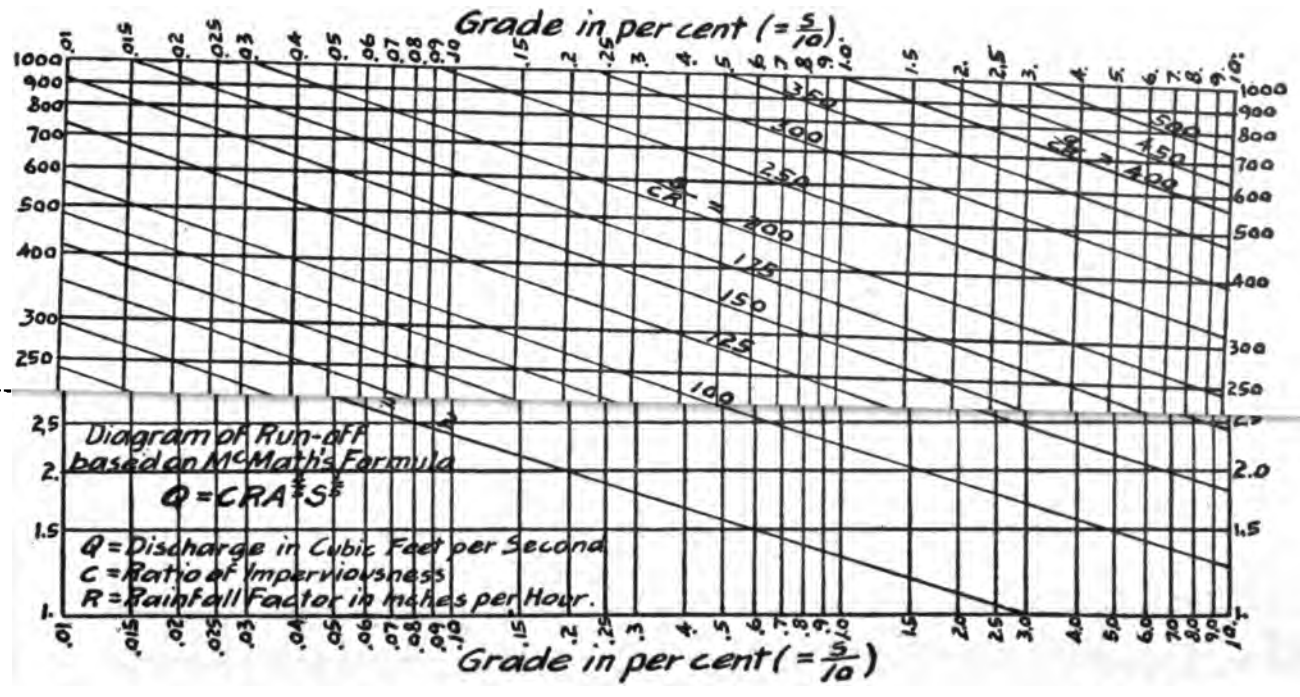
$$W = .847D,$$

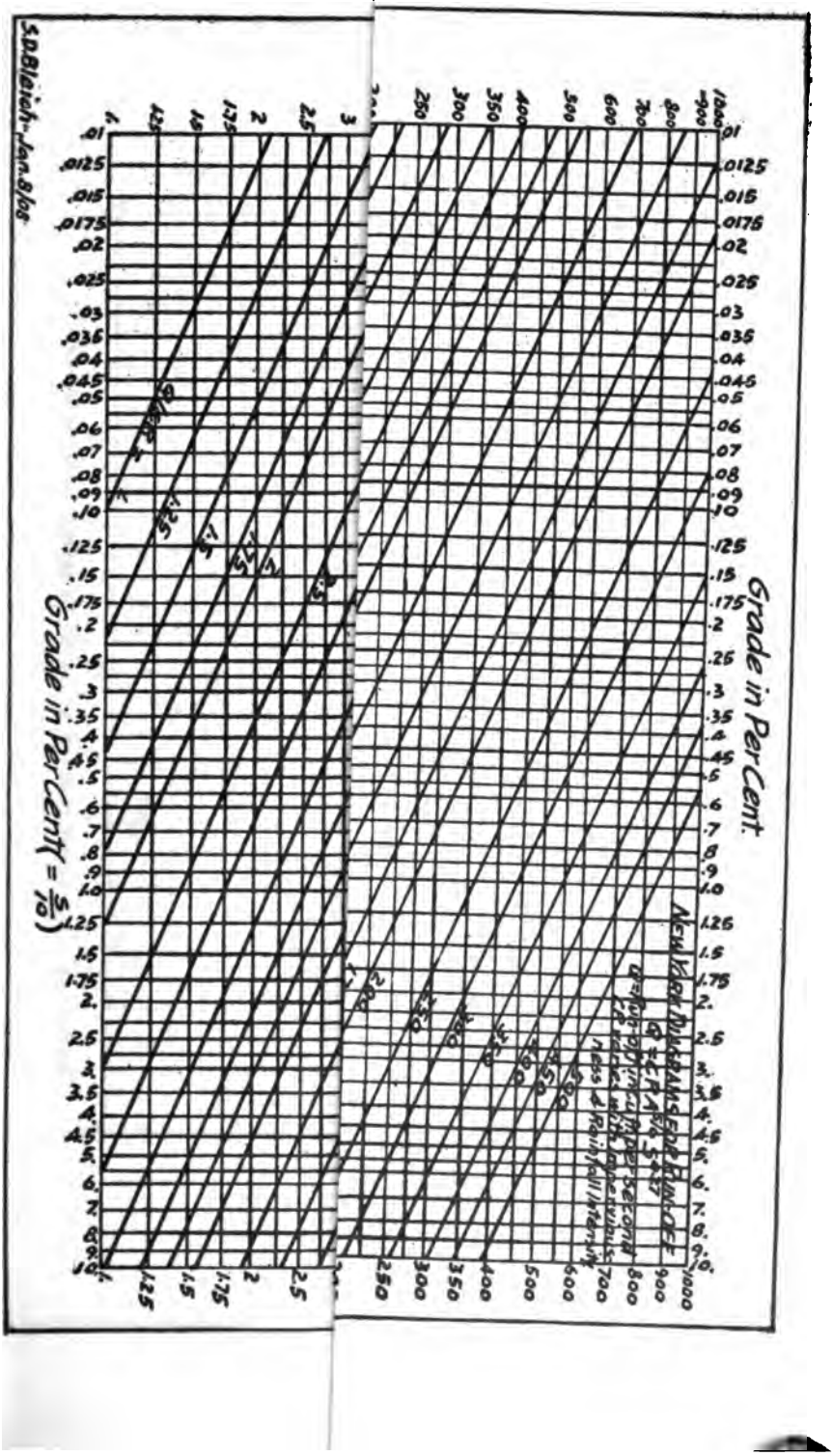
and

$$D = 1.181W,$$

in which W is the width of the egg-shaped section and D the diameter of the equivalent circular section. The following problem will illustrate how this relation is to be used in connection with the diagrams.

Obtain the discharge of a 6 ft. by 4 ft. brick egg-shaped sewer, flowing full, having a grade of 0.5 per cent. The equivalent circular sewer, having the same discharge as the egg-shaped sewer, has a diameter of $1.181 \times 4 = 4.724$ ft. The diagram for Kutter's formula (Plate 3) for $n = .015$ and a grade of 0.5 per cent. gives a discharge for this diameter of 140 cu. ft. per second and a velocity of about 7.7 ft. per second. Consequently a 6 ft. by 4 ft. brick egg-shaped sewer at a grade of 0.5 per cent. when flowing full, will


Grade in per cent (= 5/10).
Diagram of Run-off
based on McMath's Formula
Q = CRA S^½
Q = Discharge in Cubic Feet per Second
C = Ratio of Imperviousness
R = Rainfall Factor in Inches per Hour.
Grade in per cent (= 5/10)


S.D. Bleich-Jan. 8/08
Grade in Per Cent (= S/100)
Grade in Per Cent.
NEW HYDRAULIC DIAGRAMS FOR THE SOLUTION OF FORMULAS FOR FLOW OF WATER IN PIPES AND CONDUITS
Based on Kutter's Formula
Velocity
Diameter
Rate of Discharge
Loss of Head in Feet

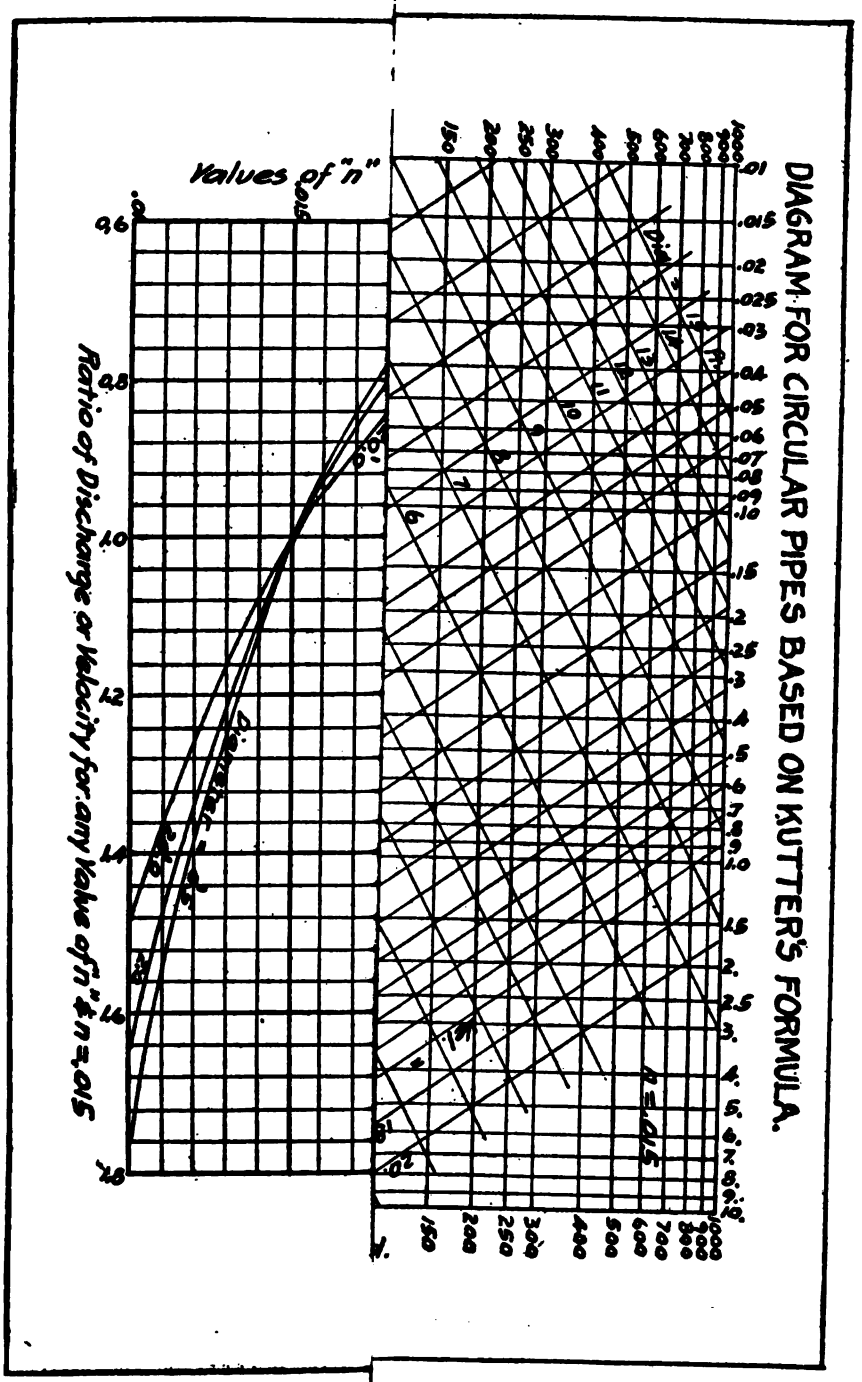
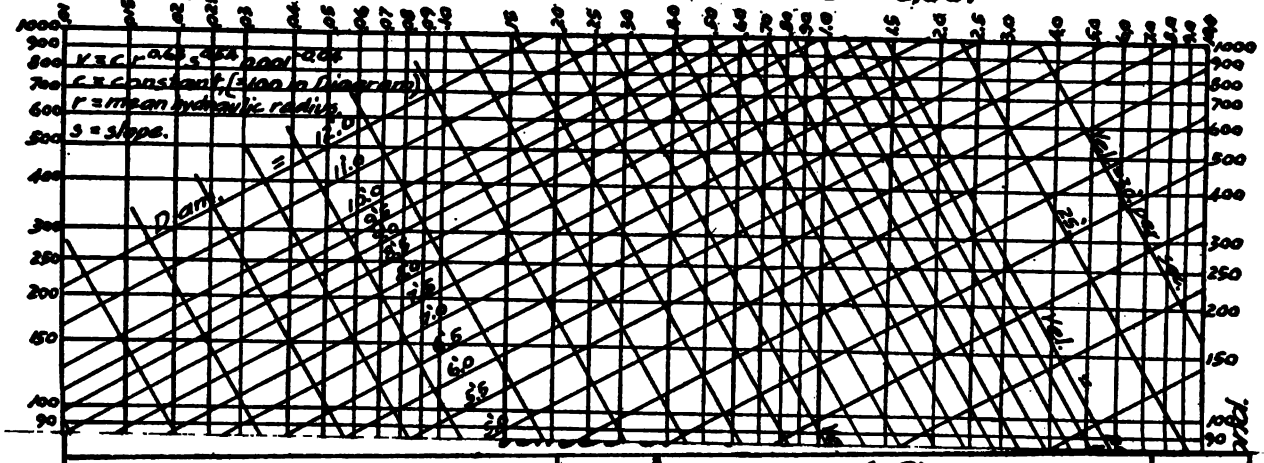


DIAGRAM FOR CIRCULAR PIPES BASED ON KUTTER'S FORMULA.
Values of "n"
Ratio of Discharge or Velocity for any Value of "n" to n=.015
n=.015

Diagram based on Formula $V = C r^{0.63} s^{0.54} 0.001^{-0.04}$



Class of Pipe	C	Class of Pipe	C
Very best Cast Iron Pipe	140	Brick Sewers	100
Good new " " "	130	Vitrified Pipe	110
Tuberculated " " "	110-80	Masonry Conduits, smooth and clean,	140
New riveted Steel Pipe	110	" " , slime coated,	130
Lead, brass, tin, & glass pipes	140-120	" " , ordinary good work,	120
Smooth wooden pipe	120		

discharge 140 cu. ft. per second with a velocity of 7.7 ft. per second. The area of the egg-shaped sewer is

$$1.1485W^2 = 1.1485 \times 4^2 = 18.38 \text{ sq. ft.}$$

The velocity through a 6 ft. by 4 ft. egg-shaped sewer having a discharge of 140 cu. ft. per second is 140/18.38 = 7.6 ft. per second, which checks closely the result from the diagram.

The diagram for Hazen-William's formula (Plate 4) with $c = 100$ for a diameter of 4.7 ft. and a grade of 0.5 per cent. gives a discharge of about 150 cu. ft. per second and a velocity of 8.3 ft. per second, which apply to an egg-shaped sewer 6 ft. by 4 ft. at a 0.5 per cent. grade.

SOLUTION OF $v = cr^m s^n$.

It will be noticed that the equation for the velocity is dependent only on the value of c, the mean hydraulic radius, and the slope. The same velocity will, therefore, be obtained for all sections having the same values for these factors. As the mean hydraulic radius for a circular section when flowing full, is one quarter of its diameter, the diagrams 3 and 4 may be used to obtain the velocity for any section when its mean hydraulic radius is known, by entering the diagram with the diameter of the circular section having the same mean hydraulic radius.

Using Kutter's formula with $n = .017$ for a section having a mean hydraulic radius of 2.5 ft. and a slope of 0.2 per cent., find the velocity. A circular sewer having a diameter of $4 \times 2.5 = 10$ ft. has the same mean hydraulic radius. The diagram for Kutter's formula with $n = .015$, a diameter of 10 ft., and a slope of 0.2 per cent. gives a velocity of about 8.2 ft. per second. The ratio diagram for $n = .017$ and a diameter of 10 ft. gives a ratio of .866. The required velocity is, therefore, $.866 \times 8.2 = 7.1$ ft. per second. The diagram for Hazen-William's formula with $c = 90$ gives a velocity of $.9 \times 8 = 7.2$ ft. per second.

The mean hydraulic radius of a standard egg-shaped sewer is $0.2896W$. For a 6 ft. by 4 ft. sewer, the mean hydraulic radius is $0.2896 \times 4 = 1.1584$ ft. The diameter of the circular sewer having the same mean hydraulic radius is $1.1584 \times 4 = 4.6336$ ft. For a grade of 0.5 per cent. and $n = .015$, the diagram for Kutter's formula gives a velocity of 7.6 ft. per second which checks the velocity already obtained by dividing the discharge of 140 cu. ft. per second by the area of the egg-shaped section of 18.38 sq. ft.

THE STANDARDIZATION OF POTASSIUM PERMANGANATE SOLUTION AND ITS SUBSEQUENT USE IN TITRATING IRON.

By CORNELIS OFFERHAUS AND ERNST H. FISCHER.

The following notes are a brief account of our experience with standards for the potassium permanganate solution. Although the accuracy of the standardization of this solution, which is extensively used for the valuation of industrial products, is of great importance, a suitable unassailable standard substance has been known only for a comparatively short time. Among the principal standards still in use, are Mohr's salt, oxalic acid, with or without water of crystallization (Hempel; Hampe; Clemens Winkler) and iron, in the form of soft iron wire. The first three substances are hard to obtain pure and to keep constant; the last one contains impurities. Treadwell * shows that it is wrong to assign to the soft iron wire its iron content (less than 100 per cent.) as iron value, as is generally done. In comparing it with electrolytic iron as to its reduction value to a potassium permanganate solution, it is found that the impurities of the soft iron wire have a greater reduction power than the iron itself and that its iron value is over 100 per cent. Treadwell recommends determining the iron value of a large quantity of soft iron wire by comparing it with electrolytic iron as to its reduction value to a permanganate solution, and to use the soft iron wire for subsequent standardization, applying the iron value thus obtained. He prepares the electrolytic iron using Classen's method † and in such quantities as to just suffice for one titration. Skrabal ‡ condemns Treadwell's proposition, as total oxidation of the carbides does not take place. He oxidizes the impurities entirely by allowing the solution of the soft iron wire to stand in a warm place over night with an excess of a warm permanganate solution. He then reduces with zinc and hydrochloric acid and standardizes, assigning to the soft iron wire its iron contents as iron value. Lunge § doubts the purity of electrolytic iron, as it may contain

* "Lehrbuch für analytische Chemie," Band II., p. 72.

† A. Classen, "Quantitative Analyse durch Electrolyse."

‡ Skrabal, *Ztschr. anal. Chem.*, 42, p. 359.

§ Lunge, *V. Int. Kongr. f. angew. Chem.*

carbon and it may hold hydrogen in occlusion. He recommends determining the iron value of the soft iron wire with pure soda, using a hydrochloric acid solution, a barium hydroxide solution, an oxalic acid and a permanganate solution as intermediate solutions. The weak points of his suggestion are the acidimetrical use of a weak acid (oxalic acid) and the many solutions and titrations it involves.

The only suitable and unassailable standard for oxidimetry, existing at the present time, is sodium oxalate, proposed by Sörensen.* This was originally recommended by Sörensen as a standard for acidimetry, although the possibility of its use as a standard for oxidimetry was mentioned by him. We possess, however, in soda a very suitable standard for acidimetry and the value of sodium oxalate therefore lies mainly in its use as a standard for oxidimetry. It was introduced rapidly as such in Europe, but it seems that it is not as yet sufficiently known in this country.

The pure salt as sold by Kahlbaum under the name of "Sodium Oxalate Sörensen" is made as prescribed by Sörensen. It contains no water of crystalization, is not hygroscopic and can be dried to 150° C. and higher, without alteration.

We compared this Sodium Oxalate "Sörensen" with Electrolytic Iron "Burgess"† to determine their suitability to serve as standards for the permanganate solution. An analysis of this electrolytic iron shows the following impurities:

	Per Cent.
C,	.00
Si,	.003
P,	.004
S,	.002
Mn,	.020

A sufficiently aged, approximately tenth-normal permanganate solution was used, burette and weights were carefully calibrated, temperature corrections were made and the rapidity of the flow of the solution was kept as constant as possible, in short, all precautions were taken to avoid the usual errors. Iron and sodium oxalate were dissolved to 50 c.c. and taken in such quantities that about 45 c.c. of the permanganate solution was used for each titration. The electrolytic iron was dissolved in 50 c.c. of ten per cent.

* *Zeitschr. f. analyt. Chem.*, 1897, p. 639; 1903, pp. 333, 512.

† *Electrochem. Ind.*, Vol. II., p. 138.

sulphuric acid solution in an apparatus as described in Classen's "Ausgewählte Methoden der analytische Chemie," Band I., p. 449. Some sodium bicarbonate was added to expel the air from the 100 c.c. flask. In performing the operation one notices the following advantages in the use of sodium oxalate over that of iron: (1) the operation of dissolving is simpler and much faster: no time is lost in cooling the solution; (2) oxidation by the air is not to be feared and the completion of the reaction is much more distinct.

The following are the results we obtained for the same permanganate solution, in using the two substances under discussion, the figure given being in each case the factor for converting the volume of solution used to the volume of tenth-normal solution which would have been required:

Sodium Oxalate "Sörensen."	Electrolytic Iron "Burgess."
0.99324	0.98899
0.99336	0.98892
0.99291	0.98840
.....	0.98808
Average, 0.99317	Average, 0.98860

One notices that the coefficients obtained with sodium oxalate are higher and show a better concurrence than those obtained with electrolytic iron.

In burning sodium oxalate, sodium carbonate is obtained and this is a means of using sodium oxalate as a standard for acidimetry as proposed by Sörensen and to compare it with pure soda, Lunge's standard for acidimetry, which years of use have proven to be correct.

The following are the average factors which we found in standardizing an approximately N/5 solution of hydrochloric acid with pure sodium carbonate, dried at 300° C. and with sodium oxalate, using methyl-orange as an indicator:

Sodium Carbonate.	Sodium Oxalate "Sörensen."
1.00092	1.00121

The sodium oxalate was burned in a platinum crucible. To prevent loss by sputtering the crucible was kept covered at the start and a small flame was applied. The flame was gradually raised and the carbon burned off. The soda was not fused. It was found unnecessary to burn or filter off the carbon entirely. The above figures do not show a practical difference, which confirms the state-

ment of Sörensen, that sodium oxalate can be used as a standard for acidimetry and puts it on a solid basis as a standard for oxidimetry. So far our results confirm the statement of Treadwell, that the impurities of iron have a higher reduction value than the iron itself (note the lower factor of the electrolytic iron "Burgess") and prompt us to recommend sodium oxalate "Sörensen" as a standard for oxidimetry in preference to the electrolytic iron.

Electrolytic iron should only be preferred in titrating iron and then only if it could be procured pure.

Perhaps the most important use made of the permanganate solution is for titrating iron in iron ores and the Zimmerman-Rheinhardt method* is generally used for this purpose, being the most rapid one.

A solution should be standardized under conditions as nearly similar to those under which it is to be used for determinations as possible. Accordingly we standardized the permanganate solution, following the Zimmerman-Rheinhardt method, with electrolytic iron "Burgess" and with sodium oxalate "Sörensen," *e. g.*, in standardizing with sodium oxalate the solutions of the Zimmerman-Rheinhardt method were also added. The operation was performed and solutions of a concentration were used as given in Treadwell's "Analytische Chem.," Band II.

The following table gives the coefficient of the permanganate solution, standardized with the two standards in question, as given above, and using Zimmerman-Rheinhardt's method.

Sodium Oxalate "Sörensen."			Electrolytic Iron "Burgess."		
Zimmerman-Rheinhardt's Method.		Direct.	Zimmerman-Rheinhardt's Method.		Direct.
0.98318			0.97796		
0.98418			0.97584		
0.98238			0.97294		
0.98325	average	0.99317	0.97558	average	0.98860
Diff. 0.00992			Diff. 0.01302		

The factors obtained with sodium oxalate show also in this case a better concurrence than those obtained with electrolytic iron and the difference of factor is practically the same in both cases, the obtainable accuracy of the Zimmerman-Rheinhardt method taken in consideration.

In standardizing the permanganate solution for subsequent use

* C. Reinhardt, *Stahl u. Eisen*, 1884, p. 709; *Chem. Ztg.*, 1889, p. 323.

to titrate iron in iron ores according to Zimmerman-Rheinhardt, it is seen we may advantageously use sodium oxalate in the place of electrolytic iron.

The titration in this case must be performed cold and the reaction takes place rather slowly at the start, but this is of minor importance since oxidation by the air does not take place.

THE RECENTLY APPOINTED HEAD OF THE DEPARTMENT OF MECHANICAL ENGINEERING.

By WILLIAM H. BURR.

It is a fortunate combination in which the man and the opportunity are fitted to each other. In a great university there are many opportunities, and it is no reflection upon anything except the usual course of human affairs, that there is not always a perfect fit between them and the man who meets them. Happily such misfits are the exception and not the rule, and the department of mechanical engineering is fortunate in being included within the rule. That department is the youngest of the departments of engineering instruction. Although much creative work of a high order had been accomplished in the department prior to Dr. Lucke's appointment as its head, there naturally remained much to be done. Mechanical engineering is one of the broadest and most important of the special fields of engineering, and in this day of great manufacturing industries and power developments of wide range and extraordinary magnitude, the educational training of mechanical engineers ought to be administered by one both profoundly grounded in theory as well as active in the affairs of that profession.

Charles E. Lucke was born in New York in 1876. After graduating from the College of the City of New York with the degree of B.S. in 1895, he pursued special studies both in Cornell University and at the University of the City of New York, where he received the degree of M.S. in 1898. Subsequently he continued his studies at Columbia University and took his doctor's degree in 1902. In 1903 he began his instruction work in Columbia University as instructor in the department of mechanical engineering. He afterwards was promoted to the grade of adjunct professor; in 1907 he was placed in charge, and in May, 1908, he was appointed professor and head of the department of mechanical engineering. The steady and even rapid advancement in his chosen line of work indicates Dr. Lucke's capacity both as an instructor and as an engineer.

There is probably no quality more needed in all professional engineering instruction than alert and vigorous treatment of such problems as are constantly arising in the administration of any department of an engineering school. The ideal instructor must be a thorough student both by taste and actual accomplishment. At the same time he must not confine himself to a mere sedentary pursuit of this most important part of his life work. He should be a man of force in his profession, recognized as an active participant in those fields of engineering in which he has laid his life work. This is a rare but by no means unknown combination, and it is fortunate for Columbia University that the present head of the department of mechanical engineering possesses it in such an eminent degree. In fact, the thoroughness and activity both as student and as an engineer which Dr. Lucke has evinced in his work are a certain promise of a highly successful development of the department of the University which has been intrusted to his care.

Among other important works which have been successfully performed by Dr. Lucke is his investigation for the Federal government regarding the fuel qualities of denatured alcohol. His wide consultation practice and other practical work in connection with gas engines has already made him an authority in that important branch of mechanical engineering. He has been a frequent contributor to engineering literature in his special field and is already the author of two books on the gas engine and power generation

ABSTRACTS—ANALYTICAL CHEMISTRY.

By ELWYN WALLER.

Crucibles of Iridium for laboratory use. Crookes (*Proc. Roy. Soc.*, 1908). The use of Ir for crucibles is recommended. Their resistance to aqua regia, fusing KOH, metallic salts, as $ZnCl_2$, fused phosphates in conjunction with carbon and carbonaceous material, etc., are noted as some of the points of advantage.

Zn, Ni, Au or Fe can be kept in fused condition for some time with but little effect on these crucibles.

Platinum as an Impurity in Borax. Rose (*C. N.*, XCVIII., 104). The finding of Pt in an ore not believed to contain it led to the examination of the assay reagents. The borax glass only was found to contain it. In the particular lot examined 1.3 parts per million were found. Borax fused in Pt dishes was found to take up perceptible amounts. The largest amounts of Pt were found in Merck's "m.g.r. puriss. borax."

Decomposing Minerals with Na_2O_2 and other agents. Walton and Scholtz (*Am. Chem. J.*, XXXIX., 771). The authors detail a number of experiments with different minerals, the charges used being varied according to the character of the material to be decomposed. The charge was well mixed, and then fired by dropping in a piece of burning Mg wire. Of the materials in the charge (besides the substance to be decomposed) a combination of some strong oxidizing agent with some oxidizable agent was needed to evolve the necessary heat. In the case of sulphides in the substance to be decomposed, there was in some cases sufficient sulphide to suffice. In most cases, however, it was necessary to add starch or ZnS. The starch was found to frequently tend to react explosively with the oxidizer, and hence was put aside to be replaced by the ZnS which reacts quietly. To obtain a more intense heat, pyrites (also powdered Mg) was used in some cases, though it is admitted that in many cases the introduction of Fe is undesirable. As oxidizers Na_2O_2 and $K_2S_2O_8$ (per sulphate) were used, sometimes separately, but usually both together. As a container the Parr bomb was first used, but later it was found that the fusions could be more satisfactorily performed in an ordinary nickel crucible, the cover being slid to one side only enough to give room for the dropping in of the burning Mg wire.

Some of the proportions used may be quoted:

Galena (over 60 per cent. Pb) 0.5 gm. ore; 8 gms. Na_2O_2; 0.8 gm. ZnS; 0.3 gm. $K_2S_2O_8$.

Franklinite 1 gm. ore (200 mesh); 8 gms. Na_2O_2; 0.3 gm. Mg.; 0.3 gm. $K_2S_2O_8$; 2 gms. pyrites.

Monazite 1 gm. ore (200 mesh); 8 gms. Na_2O_2; 1.2 gms. ZnS; 0.3 gm. $K_2S_2O_8$.

A clay containing about 61 per cent. SiO_2 and 18 per cent. Al_2O_3 was decomposed with the same charge.

BAUXITE 0.5 gm. (200 mesh) ; 8 gms. Na_2O_2; 0.5 gm. ZnS ; 1 gm. pyrites.

A titaniferous ore containing much Fe and Ti was decomposed with the same charge.

The material usually needs to be as fine as 200 mesh, and all the substances for a charge should be *quite dry* and the charge well mixed.

Ammonia in Waters. Chasttchkopf (*J. Soc. Phys. Chim. Russe*, XXXVIII., 480). A source of error has apparently been found. The author has discovered that the composition of the Nessler precipitate or of the Pt precipitate obtained from many natural waters differ from those obtained from pure NH_4 salts in a manner indicating the probable presence of methylamine. Methylamine was found to give a yellow coloration with Nessler, though with more methyl in the molecule, the color is paler. Trimethylamine gives a white precipitate. The conclusion is that many waters contain methylamine, and that those methods of determining NH_3 in waters afford erroneous results.

Potassium in Soils. Ronnet (*Ann. Chim. Anal.*, XIII., 141). To 25 gms. of the soil in a porcelain dish add 25 c.c. HNO_3 and heat for 3 hours. Then moisten with water, and add a little $Ba(NO_3)_2$. Heat to dryness, finally to incipient redness. This is to render Fe_2O_3 and Al_2O_3 insoluble. Add 10 to 20 gms. oxalic acid and wet down, then dry and heat to redness. Pulverize the mass, and place in a 250 c.c. flask, adding hot water. After agitation cool and fill to the mark and then add 10 c.c. more water to compensate for the volume of the soil. Filter off 200 c.c., evaporate to dryness and ignite after addition of a little oxalic. Dissolve in water, filter, and in the filtrate determine by Pt solution or perchlorate.

Lithium Chloride. Separation from alkaline chlorides and from $BaCl_2$. Kahlenberg and Krauskopf (*J. Am. Chem. Soc.*, XXX., 1104). The authors find that pyridine readily dissolves LiCl, whereas NaCl, KCl and $BaCl_2$ are practically insoluble in that medium. NH_4Cl, $CaCl_2$ and $SrCl_2$ are soluble. When the pyridine contains 3 per cent. of water, those salts (of Na, K and Ba) are slightly soluble, but in such small proportion that the amount is negligible, being within the limits of experimental error. In a mixture of NaCl, KCl and LiCl one treatment with pyridine was found unsuccessful, some LiCl being apparently occluded and protected by the crystals of the other salts. Dissolving in water, evaporating down, and retreating with pyridine was found to be necessary, and where the amount of salts was large, a third treatment of the kind appeared advisable. The NaCl and KCl always retained enough Li to show by spectroscopic test, but the amount was found to be practically unweighable.

Pure pyridine dissolves per 100 gms. of solvent from 13.39 gms. at 20° to 14.98 gms. at 100°. For 97 per cent. pyridine the figures are : from 14.31 at 22° to 22.48 at 97°.

Separating Magnesium from Alkalies. Gooch and Eddy (*Am. J. Sco.*, XXV., 444). The $(NH_4)_2CO_3$ method was proposed by Schaffgotsch some fifty years ago, but the results are not equal to our present requirements. It consisted in adding a concentrated solution of

$(NH_4)_2CO_3$ to the solution containing Mg and alkalies (sulfates, nitrates or chlorides) also quite concentrated, allowing to stand 24 hours, and then filtering off the crystalline $MgCO_3(NH_4)_2CO_3 \cdot 4\ H_2O$, igniting to MgO and weighing.

The authors find that by use of alcohol a satisfactory separation can be obtained in twenty minutes. The reagent used was made by saturating with solid ammonium carbonate, a mixture of 180 c.c. NH_4OH, 800 c.c. H_2O and 900 c.c. absolute alcohol, the undissolved carbonate being filtered off after several hours standing. Experiments (with chlorides) showed good results. The solution may be evaporated to a bulk of 55 c.c., an equal bulk of absolute alcohol added, and then 50 c.c. of the reagent. After stirring for 5 minutes the solution is allowed to stand 20 minutes before filtering. If the proportion of alkaline chloride is large, the precipitate should be redissolved, and reprecipitated to obtain a good separation.

Ferrous Iron in Rocks and Ores. Hillebrand (*J. Am. Chem. Soc.*, XXX., 1120). The observation of Mauzelius of the Swedish Geological Survey, already noted (vid. QUARTERLY, XXIX., 374) that fine grinding of material has a decided influence on the proportions of FeO and of H_2O in the powders, has been subjected to examination and an interesting table of results is given. Grinding was performed in air, under water, alcohol and under various other media. The explanation of the phenomenon seems to be that of "strong local heating of the grains at the moment of fracture or attrition under the pestle."

Separating Iron from Manganese. Moore and Miller (*J. Am. Chem. Soc.*, XXX., 593). Pyridine produces no precipitate in Mn(ous) salts, but when added in slight excess will throw down $Fe_2(OH)_6$ entirely free from manganese.

Iron and Vanadium Estimation in Presence of Each Other. Edgar (*Am. J. Sci.*, XXVI., 79). If a solution containing both Fe and V is reduced by SO_2 the V is reduced to V_2O_4, Fe to FeO. Titration with permanganate oxidizes the V to V_2O_5, FeO to Fe_2O_3. If the same solution is passed through a reductor and received in a solution of $Fe_2(SO_4)_3$ the V is reduced to V_2O_2, the Fe being again brought to FeO. The reducing power of the V_2O_2 is transferred to the Fe_2O_3 of the receiving solution, and now titration with permanganate shows the increased reduction due to V_2O_2 in the latter case, against that due to V_2O_4 in the former. This difference can be calculated to V. The other portion of the permanganate used has been destroyed by the FeO, which may be calculated accordingly.

Vanadium in Iron and Steel. Campbell and Woodhains (*J. Am. Chem. Soc.*, XXX., 1233). When V is present in iron or steel, dissolving in diluted H_2SO_4, about half of the V remains with the insoluble residue, in which it may be detected qualitatively by fusion with Na_2CO_3 (after burning off graphite, etc.) and testing the solution from this fusion with H_2O_2.

For quantitative work 5 gms. of the sample are treated with 50 c.c. of H_2SO_4, diluted in the proportion of about 1:3 by volume. When action has ceased at the boiling temperature, filter, and reserve the in-

soluble portion for subsequent treatment. Boil the filtrate and washings down to about 50 c.c. in an Erlenmeyer and pass in H_2S to remove Cu and As if present and to reduce any Fe that may have been oxidized. Cover and boil down to about 35 c.c. for the purpose of expelling H_2S and also concentrating the solution. Cool the flask under the tap and add 100 c.c. of alcohol. Stopper and shake at intervals for 5 or 10 minutes. By this treatment the major part of the Fe is removed as $FeSO_4$, while V and Cr remain in solution. Filter with a pump, using moderate suction, and wash with alcohol diluted with one third its volume of water. To the filtrate and washings add H_2O_2 to oxidize the remaining FeO, bring to a boil, and add Na_2CO_3 until it is distinctly alkaline. Keep at the boiling point until the precipitate becomes darker and flocculent. Filter and wash with hot solution of 0.5 per cent. Na_2CO_3. Place the filter, together with that containing the insoluble residue from the original treatment of the sample in a crucible, and burn off all carbonaceous material. Then add 5 gms. Na_2CO_3 and fuse in the covered crucible at a temperature just sufficient to keep the mass fluid. Maintain this for 15 or 20 minutes. Then add 0.3 to 0.4 gm. of powdered charcoal, cover again, and heat to the point of fluidity for about 10 minutes longer. This last treatment will reduce any chromate which may have formed but does not affect the vanadate. Cool and extract with water, which dissolves V but leaves Cr in the insoluble residue.

Steel — Determination of Molybdenum, Vanadium, Chromium and Nickel. Blair (*J. Am. Chem. Soc.*, XXX., 1229). The author finds that in separating Fe by the "ether method" (from a concentrated solution of the chlorides) all of the Mo is dissolved by the ether, and goes with the Fe. To separate it from the Fe, what is essentially Treadwell's method is used. The HCl is expelled by evaporating down with H_2SO_4, and after dilution the Fe is reduced by NH_4HSO_3. After boiling out SO_2 the Mo is precipitated by H_2S in a pressure bottle, filtered on a Gooch, and by cautious ignition converted to MoO_3 and weighed.

The aqueous solution from the ether separation is evaporated with HNO_3 to expel HCl, a few drops of SO_2 added to reduce CrO_3, and the solution when hot is poured slowly into a boiling solution of NaOH. Ni, Fe and Cu are entirely in the precipitate. Mn and Cr may be partly in the precipitate and partly in the solution. Filter, render the solution just acid with HNO_3 then slightly alkaline with NaOH, and filter again. V goes into the solution, to which is then added a 10 per cent. solution of $Pb(NO_3)_2$ and enough acetic to render it acid. On boiling the precipitate will contain all the V in combination with Pb. Dissolve in hot dilute HCl, evaporate down, add 50 c.c. HCl and evaporate again, then add 10 c.c. conc. H_2SO_4 and heat to strong fumes. When cold dilute to 150 c.c., heat to 60° or 70° and titrate with standard permanganate. Fe standard × 0.9157 = V standard.

The precipitates containing Cr, Ni, Mn, etc., are ignited and fused with 2 gms. Na_2CO_3 and 0 5 gm. $NaNO_3$. The water solution from this fusion will contain the Cr as Na_2CrO_4. Evaporate with NH_4NO_3 to render Mn insoluble, and filter it off together with other impurities

(of the reagents, etc.) that may be present. The Cr may then be determined by some convenient method.

In the insoluble portion, the separation of Ni and Cu can be accomplished by methods requiring no description here.

Vanadates — Titration. Warynski and Midvani (*Bull. Soc. Chim.* [4], III., 626). The authors find that $SnCl_2$ reduces V_2O_5 quantitatively to V_2O_4. A 2 per cent. solution is the best to use. For end reaction a spot test with a 3 per cent. solution of $(NH_4)_2MoO_4$. A very slight excess of $SnCl_2$ at once shows a blue coloration. The titration is equally accurate whether hot or cold, or in presence or absence of H_2SO_4 or HCl.

Determining Vanadic and Molybdic Acids in Presence of Each Other. Edgar (*Am. J. Sci.*, XXV., 332). V_2O_5 is reduced to V_2O_4 in acid solution by SO_2 whatever the concentration (within ordinary limits). If the solution contains not over 0.2 gm. MoO_3 in 50 c.c. and the acidity is that of 1 c.c. conc. H_2SO_4 in that volume, the MoO_3 is not reduced, and if the acidity is increased to 5 c.c. H_2SO_4, reduction does not occur even at a concentration of 0.4 gm. MoO_3 in 25 c.c. Metallic Zn (in a reductor) will reduce both. On these facts the method is based.

One portion of the solution of the two is passed through a reductor, into a solution of ferric alum. The amount of reduction effected is then determined by titration with N/10 permanganate.

Another portion, diluted and acidified to an extent to prevent action on the MoO_3 as above, is treated with SO_2, the excess of which is expelled by boiling and passing a current of CO_2. Then titration by the permanganate serves to determine the V, the equation being $5V_2O_4 + 2KMnO_4 + 3H_2SO_4 = 5V_2O_5 + K_2SO_4 + MnSO_4 + 3H_2O$. The reduction due to Mo_2O_3 by the Zn treatment can then be found by difference and the MoO_2 calculated.

Tungsten — Separation from Silica. Bourion (*C. Rend.*, CXLVI., 1102). A weighed amount of the sample is placed in a porcelain boat, which is inserted in combustion tube, and the boat is strongly heated in a current of Cl, containing a little S_2Cl_2. It is volatilized as chloride or oxychloride, which is caught in water placed in the receiver. SiO_2 remains in the boat, and may be weighed after washing and igniting. The contents of the receiver, together with ammoniacal rinsings from the tube, are evaporated with HNO_3, H_2SO_4 expelled by heating, and after treatment with NH_4NO_3 the WO_3 is ignited and weighed.

Defacz (*C. Rend.*, CXLVI., 1319) recommends a process very similar. The material is treated in a boat within a combustion tube, first in an atmosphere of H to reduce the W, afterward in a current of Cl to volatilize off the W and leave the SiO_2.

Test for Titanium. Fenton (*Proc. Chem. Soc.*, XXIV., 133). Dihydroxymaleic acid in cold dilute aqueous solution, gives an intense reddish brown solution. V does not give any such coloration. In concentrated solutions the reagent gives a voluminous chocolate colored precipitate, which acts as an acid affording bright orange colored salts, which might be used as an indicator. The compound is destroyed or prevented from forming by HF or fluorides.

Zinc in Zinc Dust. De Koninck (*Bull. Soc. Chim. Belge*, XXII., 113). In determining the amount of Zn in zinc dust by the volume of H evolved on treating with acid, it has been found that the use of rubber connections in the apparatus must be avoided, otherwise the results are too low. The phenomenon seems to be due to diffusion.

Nickel in Steels. Campbell and Arthur (*J. Am. Chem. Soc.*, XXX., 1116). The method used by many may be briefly sketched thus — dissolving — rending barely alkaline with ammonia, and titrating with standard KCN using AgI indicator. The stage of neutralization with ammonia has presented the greatest difficulty. Some substance must be present to prevent precipitation of Fe. Citric acid has been used by some analysts, but in the presence of Cr the solution is too highly colored for accurate work. Johnson (vid. QUARTERLY, XXIX., 187) found that the presence of a large proportion of citric acid (24 gms.) obviated this difficulty. The authors find that the same result can be more efficiently accomplished by the use of 13 gms. sodium pyrophosphate ($Na_4P_2O_7$). Incidentally they give modes of procedure by which Cu may be removed (which naturally interferes with the KCN titration of Ni) also for determination of Cr on the same sample.

Nickel and Cobalt, Separate Determination. Pozzi Escot (*Bull. Soc. Chim.* [4], III., 776) (vid. QUARTERLY, XXIX., 304). The author applies his ammonium molybdate separation. The solution containing the two metals is divided in halves. In one half, the sum of Ni and and Co is determined by electrolysis. The other half is concentrated and neutralized until only slightly acid. Then add a considerable excess of saturated solution of $(NH_4)_2MoO_4$ and about 10 gms. NH_4Cl, and heat up to 60 or 70°. Cool the solution under the tap to complete the separation of the Ni compound, filter cold, and wash with a saturated solution of NH_4Cl containing some $(NH_4)_2MoO_4$. The precipitate which contains only Ni may then be dissolved in hot water, the Ni precipitated out by KOH and Br, and this precipitate dissolved and subjected to electrolysis to obtain the Ni. The Co is found by difference.

Cerium in Presence of other Earths of that Group. Browning and Palmer (*Amer. J. Sci.*, XXVI., 83). The Ce must be in the cerous form. A known amount of a standard solution of potassium ferricyanide is then added, followed by solution of KOH in sufficient quantity to render the solution decidedly alkaline. After filtration, the filtrate is acidified with H_2SO_4 and titrated with permanganate. This indicates the amount of ferrocyanide formed by the reducing action of Ce_2O_3 passing to CeO_2.

Thorium in Monazite Sand. Borelli (*Chem. Ztg.*, XXXII., 509). The pulverized sand is mixed with H_2SO_4 in a platinum dish and a little HF added, the paste is then heated for some hours. When decomposition is presumably complete, diluted HCl is added; after filtration the earths are precipitated by $H_2C_2O_4$. The precipitate is oxidized and dissolved by use of $KMnO_4$ and HNO_3. This solution is neutralized with NH_4OH and H_2O_2 added which precipitates ThO_2. After filtration, this is redissolved in HNO_3, and the precipitation repeated, when the oxide may be regarded as pure, and it is washed, ignited and weighed.

Copper Plating Baths. Pannain (*Gaceta*, XXXVIII., 352). Dilute to ten times its volume, and to 25 c.c. of the dilution in a flask, add an excess of pulverized KI. Titrate free I due to Cu by standard $Na_2S_2O_3$. To the same solution add KIO_3 and titrate I due to free acid by the standard $Na_2S_2O_3$ solution.

Lead in Ores. Low (*J. Am. Chem. Soc.*, XXX., 587). Treat 0.5 gm. of the ore in the usual manner with acids finally obtaining a mixture of $PbSO_4$ and insoluble portions of the ore on a 9 cm. filter. Dissolve the $PbSO_4$ through the filter by means of $NaC_2H_3O_2$ solution containing some free acetic, running the solution back into the flask in which the ore was originally treated. Add 10 c.c. of a 5 per cent. solution of $K_2Cr_2O_7$, boil to granulate the precipitate, filter and wash but once. Now spread the filter paper flat, and rinse all the precipitate from it into a beaker, with a hot solution of $H_2C_2O_4$ (1 vol. cold saturated solution to 3 vols. water). Heat nearly to boiling, add alcohol and boil to reduce CrO_3. Filter and wash thoroughly with cold water. Put filter with precipitate in a flask with 120 c.c. water and 5 c.c. H_2SO_4. Heat and titrate with standard permanganate. Theoretically, the oxalic ($H_2C_2O_4$, $2H_2O$) value of the permanganate × 1.642 should = Pb. In practice the factor 1.669 is more nearly correct.

Lead in Alloys. Elborne and Warren (*Chem. News*, XCVIII., 1). The process depends on the insolubility of $PbCl_2$ in alcohol, the chlorides of most other metals (Pb, Sb, Cu, Fe, Zn, etc.) being soluble. 1 gm. of the alloy in fine shavings is treated in the cold with 50 c.c. conc. HCl, and a slow current of Cl passed through for 24 hours. (Such as may be generated by action in the cold of conc. HCl on lumps of pyrolusite.) Occasional agitation of the flask containing the alloy may be necessary. With some refractory alloys an occasional heating up may prove desirable. After solution has been effected, evaporate the solution in a small weighed porcelain dish, over a water-bath. Cool, then pour over it absolute alcohol, stir and immediately pour off through a dry weighed filter paper. Repeat three or four times. Finally dry the dish and filter at 100° for 3 hours and weigh $PbCl_2$.

Lead — Volumetric. Bollenbach (*Zts. Anal. Chem.*, XLVI., 582). Titration by permanganate in alkaline solution does not give concordant or satisfactory results. But if the alkaline solution of Pb is poured into an excess of permanganate, and the residual permanganate determined by titration with standard $Pb(NO_3)_2$ solution, concordant and satisfactory results are obtained. The reaction is

$$2KMnO_4 + 6Pb(NO_3)_2 + 12NaOH = 2MnO_2 + 3Pb_2O_3 + 2KOH + 12NaNO_3 + 5H_2O.$$

The permanganate should be standardized on a known amount of Pb and not by means of oxalic acid or Fe.

Red Lead. Beck (*Zts. Anal. Chem.*, XLVII., 465). Boiling gently with HCl (Gr. 1.14 to 1.15) in a current of CO_2 and conducting the evolved Cl through KI solution (free from KIO_3) is the best plan. In an atmosphere of CO_2 the free Cl has but little effect on the rubber of the stoppers. The apparatus is so set up that the HCl is forced into contact with the material, after all connections have been made,

by pressure of CO_2 which thereafter (delivered at the bottom of the flask) bubbles through the solution forcing the Cl out more rapidly. The I set free is titrated after neutralization of the liquid in the receiver by solid $NaHCO_3$.

Delicate Test for Silver. Gregory (*Proc. Chem. Soc.*, XXIV., 125). The reagents used are 20 gms. salicylic acid slightly over-neutralized with NH_4OH and diluted to 1 liter; ammonium persulphate 50 gms. per liter. To the solution to be tested is added 20 c.c. of the salicylate solution followed by 20 c.c. persulphate solution. An intense brown coloration is produced, perceptible when but 0.01 mgm. Ag is present. Pb does not give the reaction. The Ag seems to act as a catalyst, since the brown color is produced by boiling a mixture of the reagents in the absence of Ag.

Volumetric for Silver. Lang and Woodhouse (*Proc. Chem. Soc.*, XXIV., 122). The method consists in precipitating by use of excess of N/10 NaCl filtering, and then titrating the excess of NaCl with N/10 $AgNO_3$. The opalescent solution is best filtered through clean sand with the aid of a filter pump. Packing the bottom of a **U**-tube with the sand, and attaching the pump to one arm, while the liquid is poured in at the other was found to be a good device. Acidifying the solution with HNO_3 and finishing the back titration with N/100 $AgNO_3$ reduced the errors of experiment down to 0.067 per cent. The aim was to obtain a more convenient, though equally accurate, substitute for the Gay Lussac method.

Separation of Thallium from Silver. Spencer and Le Pla (*J. Chem. Soc.*, XCIII., 858). The mixture of the salts is treated in presence of about 50 c.c. of water, with a rapid stream of Cl, for about ten minutes. A white precipitate first forms which becomes temporarily brown, and then white again, the final result being the formation of the soluble $TlCl_3$ and insoluble AgCl. After boiling to expel excess of Cl, the AgCl is filtered off in a Gooch crucible. To the filtrate is added SO_2. After boiling out the excess, Tl is precipitated out by KI. The precipitate of TlI is washed with a 1 per cent. solution of KI, finally with 80 per cent. alcohol, dried at 140° and weighed.

Arsenic in Presence of Fluorides. Van Rijn (*Pharm. Werkbl.*, XLV., 98). The author found that the Marsh test failed to give any indications when testing a sample of NaF by that method, though the Gutzeit and Fluckiger reactions were readily obtained. The presence of F seems to prevent the Marsh reaction. Investigation indicated an apparent formation of AsF_3.

Arsenic or Antimony — Iodometric estimation in presence of copper. Heath (*Am. J. Sci.*, XXV., 513). It was found that the iodide method for Cu could be used with accurate results provided As and Sb were present in the pentad form, if citric acid is the only free acid present, and the free I is titrated immediately. In presence of other acids (even acetic) some reduction of the As or Sb oxide occurs. With citric this occurs but slowly. The method is conducted thus: Having the As and Sb in the solution in the pentad form, with acidity due to 1 to 2 gms. free citric acid, add 3 to 5 gms. KI and titrate the

free I due to Cu by standard $Na_2S_2O_3$ as usual. Filter off Cu_2I_2 through an asbestos filter, and add to the filtrate 1 c.c. liquid Br and boil in an Erlenmeyer. After driving out I the liquid should be clear, if not, add more Br and boil again. Concentrate to about 60 c.c. to expel excess of Br. Dilute to about 100 c.c. add 2 gms. KI, and boil down to 50 c.c. Cool, remove free I by dilute SO_2 using starch indicator. Dilute to 100 c.c., add I solution to color, and just bleach by cautious addition of dilute SO_2. Then neutralize with $NaHCO_3$, and titrate the As or Sb with standard I in the usual manner.

Tellurium Determination. Leuker and Hornberger (*J. Am. Chem. Soc.*, XXX., 387). A brief review is given of the different methods proposed. Some of these were tried, and the results are given. Gutbier's method with hydrazine gave good results but requires slow addition of the reagent, taking too much time. $NaHSO_3$ requires a 24 hours standing in a warm place, the solution being warm when mixed. A freshly prepared material for the reagent is necessary. SO_2 is also effective if the acidity of the (HCl) solution is fully 10 per cent. and the solutions are kept hot. Twenty-four hours standing is necessary. By means of a combination of SO_2 and hydrazine, complete separation can be effected in a much shorter time.

The Te as TeO_2 or as tellurate in HCl with approximately 10 per cent. of free acid, is heated to boiling, and 15 c.c. of a saturated solution of SO_2 added, then 10 c.c. of a 15 per cent. solution of hydrazine hydrochloride, and again 25 c.c of saturated SO_2 solution. Boiling is continued until the precipitated Te settles readily. This should not require over 5 minutes. Wash on a Gooch filter until all Cl is removed, then with alcohol, dry at 105° and weigh.

Chlorates, Estimation. Knecht (*J. S. C. I.*, XXVII., 434). Lunge's method consists in measuring the oxidizing power when exerted upon a known amount of $FeSO_4$. The author has found $TiCl_3$ more satisfactory than $FeSO_4$. A known volume of the solution may be measured off for the purpose, and the reaction takes place promptly in the cold, which avoids the necessity for heating (and subsequent cooling).

Phosphates in the Ammonium Sulphide Group — Qualitative. Caron and Raquet (*Bull. Soc. Chim.* [4], III., 622). The ammonia precipitate in this group frequently contains phosphates of Fe, Al, Zn or of the alkaline earths. If the precipitate is suspended in a solution containing some Na_2CO_3 (10 c.c. of an N/10 solution), and 0.5 to 1 gm. Na_2O_2 added, on boiling, Al_2O_3 or $AlPO_4$, Zn and Cr (the latter as chromate) go into solution. From the precipitate dilute acetic will dissolve the alkaline earths, leaving Mn and $FePO_4$. Addition of acetic to the Na_2O_2 solution will precipitate $AlPO_4$, or if the solution receives an excess of NH_4OH, all Al will be precipitated leaving Zn and chromate in solution.

Phosphomolybdate Precipitate. Chesneau (*C. Rend.*, CXLVI., 758). The author finds that the composition and character of the precipitate varies with the concentration (1.69 to 2.25 per cent. P) and the presence or absence of NH_4NO_3 (1.62 to 1.28 per cent. P). To obtain constant results in the analysis of a manufactured iron he recommends

for 1 gm. of metal, 5 gms. NH_4NO_3 and 50 c.c. of a reagent containing 50 gms. (cryst.) $(NH_4)_2MO_4$, 50 c.c. strong NH_4OH and 500 c.c. HNO_3 (Gr. 1.2) in the liter. Heat for 1½ hours at 65 to 70° C. Redissolve in NH_4OH, using always the same amount. Acidify with HNO_3 and add 15 c.c. of the molybdate reagent. Then heat 2 hours at 40° C. Filter and wash with pure water. After drying at 105° this precipitate contains invariably 1.60 per cent. P.

Phosphorus in Phosphor Tin. Gemmell and Archbutt (*J. S. C. I.*, XXVII., 427). The method consists in dissolving in HCl in a flask from which all air has been expelled by CO_2, and passing the evolved gases through Br with water above it. Afterward the excess of Br was removed by suitable means, and the P, now in the form of P_2O_5, determined by the ordinary method (Mg). No Sn was carried over into the solutions. The test analyses were made on material free from As, but if that element were present, any process suitable for their separation could be applied.

Loss of Carbon on Dissolving Steel in K_2CuCl_4. Moore and Bain (*J. S. C. I.*, XXVII., 845). By a carefully arranged experiment the authors were able to show that in effecting solution there was a loss of 0.04 to 0.05 per cent. of C, under the conditions ordinarily obtained by following the method prescribed at present.

Organic Combustions. Carrasco and Belloni (*J. Pharm. Chim.*, XXVII., 469). Pulverized unglazed porcelain which has been platinized, is recommended as a catalyzer in organic combustions. The porcelain "biscuit" should be pulverized and the portion passing a sieve of 80 meshes per cm., and failing to pass one of 400 meshes per cm. is taken. 50 gms. of this is treated with 1 gm. H_4PtCl_6 in 20 c.c., then dried, and again saturated with a solution containing an excess of NH_4Cl. After drying, the mass is carefully ignited. A repetition of the platinizing process may in some cases be desirable.

Graphite Analysis. Browne (*Chem. News*, XCVIII., 51). Mixture with ignited Fe_2O_3 and heating at a fairly even temperature (pale red) is recommended. Heating the Fe_2O_3 in a *covered* crucible for some time affords a slightly coherent magnetic powder nearly black in color. About 5 gms. of this material is first heated in a shallow dish or wide-mouthed crucible (open) at not over pale red for an hour. Then weigh, add 0.5 gm. of the graphite, stir in and heat as before for one or two hours, stirring occasionally. The carbon is thus burned off (determined by loss of weight) and the material is in condition to use for another determination.

Carborundum. Chesneau (*Ann. Chim. Appl.*, XIII., 85). Some amorphous carborundum is always formed in the preparation of the crystallized product, and in that form has some uses. Under the microscope the product shows black grains of carbon, the green amorphous carborundum, and crystals of a mineral having approximately the composition of anorthite. To analyze, grind first in a porcelain mortar, then in agate, sieve it, and heat the powder for 2 hours at bright red. Then ignite 1 gm. of this material in a weighed platinum crucible to

burn off the C which may be determined by loss, then treat with 20 c.c. HF and 1 c.c. conc. H_2SO_4, evaporate slowly to dryness, then add conc. HCl and boil for a short time. Dilute with hot water, warm for a few minutes and filter, washing with dilute HCl at first, afterward with boiling water. The residue consists of pure carborundum.

If necessary to determine Si, fuse 0.2 gm. with a mixture of 5 parts alkaline carbonate and 1 part alkaline nitrate and conduct the separation of SiO_2 in the usual manner.

ABSTRACTS OF RECENT MINING DECISIONS.*

LOCATION OF CLAIMS.

LOCATION OF MINING CLAIM — RECORDING CERTIFICATE.

The statute of Nevada providing for the recording of certificates of location of mining claims, was held to be directory only; and where the doing of the acts required to make a valid location was fully proved by other testimony, it was said that the location would not be invalidated by a failure to record the certificate thereof.

Wailes *v.* Davies, 158 Federal 667, December, 1907.

MINING CLAIM — DISCOVERY — PRIORITY.

One person located and staked a placer mining claim on May 25, but made no discovery at the time; and thereafter left to get supplies and necessary equipment to proceed with the development work. In the meantime another person located and staked the claim, and when the first locator returned on June 9 he found the second locator in possession. The first locator entered peaceably on June 29, built a cabin thereon and proceeded to sink a shaft. During the same time the second locator remained on the claim living in a tent and was engaged likewise in sinking a shaft. The first locator found sufficient gold in the shaft sunk by him to warrant him in the further expenditure of time and money in the development of the claim. The location made by the first locator on May 25 unaccompanied by discovery at the time, gave to him no right subsequently to return and take possession of the claim after the second locator had made due location and taken possession for the purpose of exploration. But both locators being in possession by common consent on and after June 8 it became a race of diligence between them to discover gold, and he who first discovered it obtained the prior right. While his discovery did not relate back to the date of his location, yet his location was made valid by discovery and became effective from that date and gave him the full right to the claim to the exclusion of all others.

Johnson *v.* White, 160 Federal 901, February, 1908.

LODE AND PLACER LOCATIONS.

According to the United States Statutes where the lode or vein within the limits of a placer location is excepted from the patent to the placer claim, such lode or vein and twenty-five feet on either side thereof is open to exploitation and location by any citizen of the United States for which purpose he is entitled to enter into possession.

Noyes *v.* Clifford, (Mont.) 94 Pacific 842, March, 1908.

* Prepared for the SCHOOL OF MINES QUARTERLY by J. W. Thompson, Attorney-at-Law, Indianapolis, Indiana.

LOCATION OF MINE — "VEIN" OR "LODE."

The United States Statutes provide that mining claims or "veins" or "lodes" of quartz or other rock in place bearing gold or silver, previously located, shall be governed as to length along such vein or lode by the customs, regulations and laws in force at the date of such location. The statutes further provide that where any person, in possession of a placer claim which includes a vein or lode known to exist within its boundaries, applies for a patent for the placer claim, but not including such vein or lode in his application, then the application shall be construed as a conclusive declaration that such placer claimant has no right of possession of the vein or lode; but when the existence of the vein or lode is not known, then a patent to the placer claim shall include and convey all valuable mineral or other deposit within its boundaries. A "known vein or lode," in the sense here used, is one clearly ascertained and of such extent as to render the land more valuable on that account and justify its exploitation and development. In the sense here used the terms "vein" and "lode" are synonymous.

Noyes *v.* Clifford, (Mont.) 94 Pacific 842, March, 1908.

LOCATION NOTICE — AMENDMENT.

Where the location of a mining claim is made in good faith it will be sufficient if the language employed in the description will impart notice to subsequent locators. And amendments may be made under the statute where they do not interfere with existing rights; and when so made they relate back to the date of the original location. In permitting amendments it is the policy of the law, not to avoid a location for defects in the notice, but rather give the locator an opportunity to correct his certificate or notice whenever defects are found therein.

Bismark Mt. Gold Mining Co. *v.* North Sunbeam Gold Co., (Idaho) 95 Pacific 14, March, 1908.

RECORDING LOCATION NOTICE — EFFECT.

The location notice when recorded is prima facie evidence of all the facts it is required by the statute to contain, and which are sufficiently set forth therein; and with the affidavit of the locator attached setting forth the fact that the ground was unoccupied mineral land of the United States at the time of his location, when introduced in evidence in an adverse suit, makes a prima facie case. The notices are prima facia evidence of all facts required by the statute to be stated, which are in fact, sufficiently stated in the notice. A mistake in the notice may be corrected by oral evidence! The fact as to whether the work was done is the principal question, and not its method of proof.

Bismark Mt. Gold Mining Co. *v.* North Sunbeam Gold Co., (Idaho) 95 Pacific 14, March, 1908.

LOCATION OF MINING CLAIM— NATURAL OBJECTS.

The purpose of the law in requiring the location of mining claims to be made with reference to some natural object or permanent monument

is said to be for the purpose of directing attention in a general way to the vicinity or locality in which such mining claim was to be found; but the natural objects or permanent monuments required may be either on or off of the ground located.

Bismark Mt. Gold Mining Co. *v.* North Sunbeam Gold Co., (Idaho) 95 Pacific 14, March, 1908.

MINING CLAIM — DISCOVERY — BOUNDARIES.

Where the locators sunk a discovery shaft within the original boundaries of their claim six or seven months before they attempted to extend the boundaries so as to include a portion of the claim of another locator within the overlap, such discovery was said to relate to the original boundaries of the locators' claim, and not to the claim within the extended boundaries, so as to confer on such locators any rights in the overlap on which the locators of such second claim subsequently made the first discovery, and where such second locators' occupation and discovery were without opposition.

Biglow *v.* Conradt, 159 Federal 868, March, 1908.

MINING CLAIM — AMENDING DECLARATORY STATEMENT.

The filing of an amended declaratory statement of mining claims, under the statute of Montana, cannot create a right of possession or location in the premises claimed under the first location, which did not exist prior to the filing of such additional certificate. It can confer no additional right, and is therefore evidence of none against any intervening or preëxisting right of another. Hence, except as against such intervening right an additional certificate serves the same purpose, in its admission as evidence as that of an original location certificate, and will relate back to the first location. The intent of the statute is that the additional certificate, or amendatory declarations, show opportunity to cure defects in the original and thereby to put the locator, where no other rights have intervened, in the same position that he would have occupied if no such defects had occurred.

Milwaukee Gold Extraction Co. *v.* Gordon, (Mont.) 95 Pacific 995, May, 1908.

LOCATION OF OIL PLACER MINING CLAIM — POSSESSION.

Where a locator entered upon vacant and unappropriated land, and staked the land, and put up notice, and recorded the claim, and did all acts necessary for its location, except discovery, he had a right to take actual possession, and continue therein for a reasonable time, while exploring the land for purpose of discovery; and such acts would indicate the extent of the surface intended to be appropriated, as well as the extent of such possession, and the locator would be protected against the forcible, fraudulent or surreptitious intrusion of others.

Phillips *v.* Brill, (Wyo.) 95 Pacific 856, May, 1908.

LOCATION OF MINING CLAIMS — OVERLAPS.

A mining company located a claim and thereafter on the same day located another claim, the latter overlapping a part of the former. The

various acts requisite to a valid location were first performed on the claim first located, and subsequently on the claim last located. Under such circumstances the first location constituted the senior location, and the overlapped — the disputed territory — was a part of such first claim, and was thereby segregated from the public domain. On the abandonment of such first location, by reason of the failure to perform the annual assessment work, such overlapped territory did not become a part of such second claim but reverted to the public domain and was subject to relocation. Thereafter a third person located a claim which included such conflict territory and took the necessary steps for a valid location. In a contest as to the right of such overlapped territory the person making the last location had the title to such conflict territory.

Moorhead *v.* Erie Mining & Milling Co., (Colo.) 96 Pacific 253, June, 1908.

CONFLICTING RIGHTS.

FORFEITURE OF CLAIM — BURDEN OF PROOF.

Where a party seeks to establish the forfeiture of a mining claim the burden of proof is upon him, and in order to establish such forfeiture, the proof must be clear and convincing that the owner has failed to comply with the law.

Wailes *v.* Davies, 158 Federal 667, December, 1907.

LOCATION OF CLAIM — AMENDMENT OF NOTICE.

A person in possession of a mining claim, and who has done the actual physical work required by the statute, and such work exists as evidence of the possession, and where there are no intervening rights, such person may amend his location, and thereby perfect his entry; and his right cannot then be defeated by one who had made no peaceful entry for possession of the land, and who had done no work thereon.

Ware *v.* White, (Ark.) 108 Southwestern 831, January, 1908.

MINING CLAIM — CONTRACT TO PURCHASE — RIGHT TO ACQUIRE TITLE BECAUSE OF VARIANCE.

Certain persons contracted to purchase mining claims which had been surveyed and monuments erected, and for which patents had been issued; but a variance was discovered between the ground conveyed by the patents and the ground intended to be denounced. The purchasers were not estopped, because of the contract of purchase, from denouncing claims covering the territory intended to be included by the vendors in their claims, and from acquiring title to the property adversely to the vendors.

Butterfield *v.* Nogales Copper Co., (Ariz.) 95 Pacific 182, March, 1908.

MINING CLAIM — POSSESSION.

Where actual possession was not taken by a purchaser under a contract to purchase mining claims not described by metes and bounds, such purchaser was not in constructive possession of the ground claimed

by the vendor under his original location, and not included within the patents to the claims, for the reason that a person cannot be constructively in possession of property not falling within the description of some muniment of title held by him.

Butterfield *v.* Nogales Copper Co., (Ariz.) 95 Pacific 182, March, 1908.

ABANDONMENT OF MINING CLAIM — RELOCATION.

An actual abandonment of possession by a locator of a mining claim, such as would work an abandonment of any other easement, would terminate all the right of possession which the locator then had, and the ground embraced in such mining location would again become a part of the public domain, and render it subject to another location before the expiration of the statutory period for performing annual labor.

Farrell *v.* Lockhart, 28 Sup. Ct. 681, March, 1908.

RIGHTS TO MINING CLAIM.

In an adverse suit to determine the ownership of an oil placer mining claim, each party must stand upon his own rights, and each must recover on the strength of his own claim, and not on the weakness of the title or claim of the other; and where both parties failed to establish a right to possession, neither would be entitled to judgment.

Phillips *v.* Brill, (Wyo.) 95 Pacific 856, May, 1908.

PLACER CLAIM — LOCATION OF DISCOVERY SHAFT.

The fact that one half the diameter of the discovery shaft was on an oil placer mining claim, was held to be a sufficient showing of discovery within such claim; and such claim would not be invalidated by the fact that such discovery shaft was partly on another claim. Neither would it be inferred that the well deviated away from such claim in its descent, in the absence of evidence to the contrary.

Phillips *v.* Brill, (Wyo.) 95 Pacific 856, May, 1908.

MINING LOCATION — TRESPASS.

A right to a mining claim cannot be initiated by a trespass, but the general rule is that a mining location, to be valid, must be good when made.

Phillips *v.* Brill, (Wyo.) 95 Pacific 856, May, 1908.

LOCATION OF OIL PLACER MINING CLAIM.

The locator of one placer oil mining claim was held to have no right to another claim that was properly staked and notice put up, and the claim recorded, merely because the discovery under which the other locator claimed, was on the boundary line between such claims, and where the first locator claimed title to another claim on the strength of the same discovery well.

Phillips *v.* Brill, (Wyo.) 95 Pacific 856, May, 1908.

CONFLICT OF MINING CLAIMS — ADVERSE SUITS — PROOF.

In a contest to determine the title to conflicting mining claims, in order to make out a prima facie case the plaintiff must show in addition to the other legal requirements, that the conflicting claim was not covered by a prior location, or, if so, that it was invalid; or that such prior claim had been forfeited for nonperformance of annual labor, or that the claim had been abandoned.

Lozar *v.* Neill, (Mont.) 96 Pacific 343, June, 1908.

ADVERSE SUITS — EFFECT OF NON-SUIT.

Where a plaintiff in an adverse suit to establish title to a disputed claim, fails to establish his claim, he is properly non-suited, and he has no right thereafter to participate in the proceedings. After such a non-suit the hearing thereafter is ex parte as to the defendant, and the presumption is that all proceedings were regular and the judgment for defendant correct.

Lozar *v.* Neill, (Mont.) 96 Pacific 343, June, 1908.

MINING CLAIM — CONVEYANCE OF PART — EFFECT.

A conveyance of a definite and designated tract of a mining claim owned by tenants in common, giving the grantee the same rights as the grantor had, severs completely such tract conveyed, and the grantors have no interest in a discovery made thereafter by the grantee.

Merced Oil Mining Co. *v.* Patterson, (Cal.) 96 Pacific 90, May, 1908.

OWNERSHIP OF NATURAL GAS — RIGHT TO TAKE.

Before natural gas is taken from the earth it is fugitive in its nature and belongs to the common surface owners. There is no property in natural gas until it is taken from the earth. The right of the surface owners to take gas is subject only to the limitation that it must be for a lawful purpose and in a reasonable manner.

Louisvile Gas Co. *v.* Kentucky Heating Co., (Ky.) 111 Southwestern 374, June, 1908.

MINING LEASES.

MINING LEASE — DUTY AND LIABILITY OF ASSIGNEE.

An assignee who takes the assignment of a mineral and stone lease subject to all the conditions and terms specified in the lease, occupied the place of the assignor and assumed to discharge all the obligations of the lease, and the lessor was entitled to proceed directly against the assignee for any breach of the conditions of the lease.

McGoodwin *v.* Lusterine Mining & Polishing Co., (Ky.) 110 Southwestern 409, May, 1908.

SALE OF MINING LEASE — PAYMENT OUT OF "FIRST NET PROFITS."

The owner of a mining lease sold a two thirds interest therein, and the purchaser agreed to pay therefor out of the "first net profits of the mine." In construing this contract it was decided that the "first net

profits" comprised the first excess of current receipts for ore taken from the mine over and above any excess of the current expenses for producing such ore and the necessary charges for repairs and betterments; but the term did not include the right of the purchasers to be reimbursed for moneys expended in the development of the mine, sinking the shaft, erection of mill, etc.; that it was not intended that the purchasers should be reimbursed for all their outlays in the way of capital before they should pay this deferred claim to net profits.

Crocker *v.* Barteau, (Mo.) 110 Southwestern 1062, May, 1908.

OIL AND GAS LEASE — DILIGENCE IN PROSECUTING WORK.

An oil and gas lease for ten years, and longer if oil and gas were found in paying quantities, provided that the lessor should receive a certain per cent. on any oil and gas found, and so much per year from gas from each well drilled, and the lessee to commence operations within one year, was held not to require uninterrupted and continuous work on the part of the lessee; but while there was the implied covenant that the lessee would prosecute the work of development with reasonable diligence, he was not compelled to continue it without intermission, and the drilling of different wells at different times though all were not done or begun within a year, was not sufficient ground for forfeiting the lease.

Phillips *v.* Hamilton, (Wyo.) 95 Pacific 846, May, 1908.

ASSESSMENT WORK.

CHARACTER OF ASSESSMENT WORK REQUIRED.

The United States statute requires that not less than one hundred dollars worth of labor shall be performed or improvements made on a mining claim during each year; but the statute does not specify the kind or character of the labor. It has accordingly been held that labor expended in extracting ore from the claim was within the statutory requirement. It is only when labor is performed outside of the boundaries of the claim that its character becomes material, and in that case it must tend to the development or improvement of the claim, or it will not count.

Wailes *v.* Davies, 158 Federal 667, December, 1907.

LIABILITY OF INJURY TO MINER.

ENTERING MINE AGAINST CAUTION — INTENT.

The statutes of some of the states make it unlawful for a miner to enter any place in a mine against caution, or to disobey orders, or to do any other act whereby the lives or health of persons or the security of the mine would be in danger. In a prosecution for the violation of such a statute, it was held that the intent to endanger life or property was not an element of the offense; that the intentional doing of an act with knowledge that in so doing life or property would be endangered, was the gist of the action. The caution as used in the statute, was held to mean simply to give notice of, or warn against, danger.

Koppala *v.* State, (Wyo.) 93 Pacific 662, February, 1908.

MINING SHAFT — DANGEROUS PLACE.

The fact that the entrance to a mine shaft was unlighted upon a dark night was not sufficient to render such shaft so obviously dangerous, or the hazard in going about it so apparent, that a person of ordinary prudence would not incur the risk.

Moseley *v.* Black Diamond Coal & Mining Co., (Ky.) 109 Southwestern 306, April, 1908.

INJURY TO MINER — PRESUMPTION AS TO INJURY.

Where a mine shaft was enclosed with a fence provided with gates which were constantly left open, and a miner was killed by falling into the shaft, in the absence of evidence to show the manner in which the deceased came to his death, the court held that it would be presumed that the deceased did not climb over the fence and fall into the shaft, but rather that he walked through the open gate.

Moseley *v.* Black Diamond Coal & Mining Co., (Ky.) 109 Southwestern 306, April, 1908.

COAL MINING COMPANY — LIABILITY FOR MEDICAL SERVICES TO AN INJURED EMPLOYE.

A coal mining company was held not liable for medical services rendered an injured employe at the request of the president of the company; and in the absence of any showing as to the nature of the employment of such injured person, the extent of the injury or of any emergency which rendered him unable to care for himself.

Cushman *v.* Clover Land Coal & Mining Co., (Ind.) 84 Northeastern 759, May, 1908.

MISCELLANEOUS.

MINING CLAIM OF CORPORATION — WORK BY STOCKHOLDERS.

A stockholder in a mining corporation is said to have such a beneficial interest in the corporate property that any work done by him on the unpatented claims of the corporation could be counted as representative work, and if sufficient in amount and done at the proper time, would prevent a forfeiture of the claim.

Wailes *v.* Davies, 158 Federal 667, December, 1907.

MINING PARTNERSHIP.

By an agreement between the owner of a mine and another person, the latter was to furnish the necessary labor in operating the mine, and each was to receive one half of the profits, to be divided after they had reached a certain amount, and the latter person was then to receive a half interest in the mine; or such person was entitled to purchase a half interest in the mine at any time for a certain sum. Such second person then entered into an agreement with other persons by which they contributed various amounts to work the mine, and for the purpose of securing the option and such second person agreed to convey to those so contributing, of the interest he was to receive, amounts in

proportion to their contribution. In a controversy among such persons it was held that the agreement created the relation of partners as between such second person and others contributing.

Bentley *v.* Brossard, (Utah) 94 Pacific 736, March, 1908.

NATURAL GAS — WASTE AND USE.

It is now the law that the owner of a gas well has a right of action against the owner of other wells in the same district for damages for illegitimate waste or destruction of the gas; but no right of action exists for exhaustion resulting from the legitimate use or sale of the gas.

Calor Oil and Gas Co. *v.* Franzell, (Ky.) 109 Southwestern 328, March, 1908.

CONTRACT FOR SALE OF MINE — PERFORMANCE OF CONDITIONS.

A contract for the sale of mining claims which provided that the purchaser should run certain cross-cuts, shafts and drifts, will not be specifically enforced where there is no time specified in the agreement when the work should be done, and where there was no allegations that the plaintiffs had been damaged by the failure to perform these particular acts.

Mallory *v.* Globe Boston Copper Mining Co., (Ariz.) 94 Pacific 1116, March, 1908.

SALE OF MINE — BROKER'S COMMISSION.

A mining corporation was liable for the services of a broker employed by its manager and treasurer, where it received the price demanded for its property and executed a conveyance with the presumed knowledge of the broker's services. This was said to be within the rule that a principal cannot accept part of an agent's act inuring to his benefit and reject that portion to his injury.

Dillard *v.* Olalla Mining Co., (Ore.) 94 Pacific 966, April, 1908.

BREACH OF CONTRACT — SUBSTITUTE FOR DAMAGES.

A contract for the sale of a mining claim provided that on non-compliance with any of its terms, the purchaser should forfeit all machinery and appliances placed on such claims, and that such forfeiture should be in full liquidation of all claims and demands. This was held to provide for the measure of damages for the breach of the contract, to the exclusion of a remedy by cancellation of the contract of sale, or specific performance.

Mallory *v.* Globe Boston Copper Mining Co., (Ariz.) 94 Pacific 1116, March, 1908.

LABORER'S LIEN ON MINING CLAIM.

The Alaska code giving a lien to laborers for work done on a mine at the instance of the owner or his agent, was held sufficient to give a lien on the interest of the owner of a mining claim for improvements made thereon under the directions of a lessee with the owner's knowl-

edge and in the absence of any disclaimer of responsibility by him. And in an action to foreclose such lien in such case the lessee is not a necessary party.

Cascaden *v.* Wimbish, 161 Federal 241, April, 1908.

MINING CLAIM — LABORER'S LIEN — NATURE OF WORK.

Under the Alaska code giving a mechanics' lien for work done on a mining claim, persons who clean up and wash gold taken from a mining claim are entitled to a lien for "labor done upon the claim." So where men were hired to work in making improvements on a mining claim at a certain sum per day and their board, one who devoted a part of his time to cooking for himself and others, was entitled equally with the others to a lien for his wages.

Cascaden *v.* Wimbish, 161 Federal 241, April, 1908.

SALE OF MINING STOCK — FRAUD.

The owner of a mining stock induced a third person to purchase by fraudulently representing that the stock purchased was to be treasury stock; but instead of treasury stock he transferred to the purchaser his own private stock. In an action for damages, it was held that inasmuch as the treasury stock under any circumstances is worth neither more nor less than any other stock, that the damages were wholly speculative and there could be no recovery. The court intimated that if the purchaser had acted promptly he might have rescinded the sale, reassigned the shares, and recovered the purchase money from the person to whom he paid it.

Findlater *v.* Dorland, (Mich.) 116 Northwestern 410, May, 1908.

IMPORTATION OF COAL AND SLACK — CUSTOMS DUTIES.

An importation of a mixture of bituminous coal and slack in the proportion of two to one was subjected to the rates of duty respectively provided therefor in the tariff on the basis of this proportion, and regardless of their intermingled condition. As the proportion could be fixed by the use of scale and screen on a single tub, the law would not cast on the importer the burden of the useless separation of the two kinds of coal; and the proportion of slack was sufficiently determined by testing a sample weighing 113 pounds out of an importation of 175 tons.

United States *v.* Bond, 161 Federal 165, February, 1908.

PURCHASE OF MINING CLAIM — COMPENSATION OF BROKER.

A broker contracted with a prospective purchaser to assist him in purchasing mining claims and consolidating them with other property. The attempted purchase was unsuccessful and the project abandoned. The prospective purchaser afterwards negotiated with other persons to carry out the same enterprise, and the purchase was finally made and the consolidation of the claims effected in connection with such other persons wholly independent of such broker. In an action by the broker

for commission, it was held that he was not entitled to recover; and where he alleged that he agreed to assist the purchaser in securing title to such mining claims, and that the purchaser, by reason of his assistance, did secure the title to such claims, he was held bound to prove such allegations and could not recover in the absence of such proof.

Bailey *v.* Carlton, (Colo.) 95 Pacific 542, April, 1908.

MINING — OBSTRUCTING A STREAM WITH TAILINGS.

A person engaged in mining may deposit his tailings in a natural water course to a reasonable extent; but he has no right to make such deposit to the extent of diverting the water from the natural channel and causing it to overflow the lands of a lower owner to his damage.

Salstrom *v.* Orleans Bar Gold Mining Co., (Cal.) 96 Pacific 292, May, 1908.

MINING — ADVANCES BY STOCKHOLDERS.

Where in the absence of funds of the corporation, certain stockholders tacitly agreed to, and did, advance funds with which to continue the mining operations, this was held not to constitute them a mining partnership, and did not make them personally liable for the debts of the corporation, but were no more than advances to the corporation.

Dodge *v.* Chambers, (Colo.) 96 Pacific 178, June, 1908.

DEPARTMENTAL NOTES.

DEPARTMENT OF CHEMISTRY.

(From Annual Report of the Head of Department for the year 1907–08.)

At the beginning of the session, Professor J. S. C. Wells resumed his duties in the department after two years' leave of absence.

During the year Mr. J. Edwin Sinclair resigned as assistant in analytical chemistry to accept a position in the Newark High School, and his place was filled for the remainder of the year by Mr. A. P. Lothrop.

Dr. Alfred Hoffman and Messrs. Eric Higgins, C. E. Taylor and Roland Calberla have respectively served as honorary assistants in organic, physical, analytical and electro-chemistry.

The department has been greatly embarrassed during the past year in not being able to provide adequate accommodations for the college students who are obliged to take Chemistry A. On account of the laboratory work being done on Saturday afternoons, many students found it impossible, for various reasons, to take the course. The nucleus of a fund for fitting up Room 103 Havemeyer as a laboratory for College students taking this course has been promised by Mr. Neugass, in memory of his son, the late S. Neugass, who was formerly a student in the chemical department, and it is hoped that sufficient money may be raised to fit up the laboratory before the opening of the next college year.

The details of attendance are shown in the following table:

Number of different students taking one or more courses in chemistry, 1907–1908.

Architecture	1	
Pure Science specials	2	
Teachers College	6	
Pure Science, M.A.	14	
Pure Science, Ph.D.	16	
		39
Applied Science, 1908	29	
" " 1909	63	
" " 1910	169	
" " 1911	195	
" " Specials	26	
		482
Columbia College, 1908	25	
" " 1909	50	
" " 1910	87	
" " 1911	113	
" " Specials	3	
		278
		799

This is an increase of 74 as compared with last year.

As some of the students attended two or more courses, the total enrollment aggregates 1939.

The number of students receiving practical instruction in the different laboratories was as follows:

General Chemistry, Columbia College	161
Qualitative Analysis	297
Quantitative Analysis	179
Assaying	73
Organic Chemisty	32
Industrial Chemistry	20
Physical Chemistry	24
Chemical Microscopy	10
	796

The following contributions from the Havemeyer laboratories were published during the year, July, 1907, to June, 1908, inclusive:

No. 137. The Calculation of Chemical Equilibria. By K. George Falk. School of Mines Quarterly, **28**, 441.

No. 138. The Balance of Acid-forming and Base-forming Elements in Foods. By H. C. Sherman and J. Edwin Sinclair. Journ. Biol. Chem., **3**, 307.

No. 139. Some New Double Phosphates of Chromium. By Louis J. Cohen. Journ. Am. Chem. Soc., **29**, 1194.

No. 140. Molten Hydrated Salts as Solvents for the Freezing Point Method. By J. Livingston R. Morgan and H. K. Benson. Journ. Am. Chem. Soc., **29**, 1168, and Ztschr. anorg. Chemie, **55**, 261.

No. 141. Determination of Molecular Weights by Distribution Experiments. By J. Livingston R. Morgan and H. K. Benson. Journ. Am. Chem. Soc., **29**, 1168, and Ztschr. anorg. Chemie, **55**, 356.

No. 142. Molten Hydrated Salts as Solvents for the Freezing Point Method, II. By J. Livingston R. Morgan and F. T. Owen. Journ. Am. Chem. Soc., **29**, 1439, and Ztschr. anorg. Chemie, **56**, 168.

No. 143. Platinum Resistance Furnace for Melting Points and Combustions. By S. A. Tucker. Journ. Am. Chem. Soc., **29**, 1442.

No. 144. On Some Analytical Properties of Pinewood Oils. By Otto Kress. School of Mines Quarterly, **29**, 46.

No. 145. The Ignition Temperatures of Gaseous Mixtures. (Second paper.) By K. George Falk. Journ. Am. Chem. Soc., **29**, 1536.

No. 146. The Determination of Carbon Monoxide in Atmospheric Air. By J. Livingston R. Morgan and John E. McWhorter. Journ. Am. Chem. Soc., **29**, 1589.

No. 147. The Stereo-chemistry of Indigo. (Preliminary communication.) By K. George Falk and J. M. Nelson. Journ. Am. Chem. Soc., **29**, 739.

No. 148. Experiments upon Barfoed's Acid Cupric Acetate Solution as a means of distinguishing glucose from maltose, lactose and sucrose. By F. C. Hinkel and H. C. Sherman. Journ. Am. Chem. Soc., **29**, 1744.

No. 149. The Weight of a Falling Drop and the Laws of Tate. The Determination of Molecular Weights and Critical Temperatures of

Liquids by the aid of Drop Weights. By J. Livingston R. Morgan and Reston Stevenson. Journ. Am. Chem. Soc., **30**, 360.

No. 150. The Electrolytic Determination of Bismuth. By F. J. Metzger and H. T. Beans. Journ. Am. Chem. Soc., **30**, 3589.

No. 151. Researches on Quinazolones (twentieth paper): On Certain 7-nitro-2-methyl-4-quinazolones from 4-nitro-acetanthranil. By Marston Taylor Bogert and William Klaber. Journ. Am. Chem. Soc., **30**, 805.

On October 30, 1907, Professor Chandler delivered the third non-technical lecture before a large audience in Havemeyer Hall, the subject being "Chemistry."

On December 12, Professor Chandler lectured on "The Electrochemical Industries at Niagara Falls" before the Sigma Xi Society at Columbia University.

On February 4, he lectured on "Electrochemistry" before the Brooks Club of New Bedford, Mass., and on February 5, repeated the same lecture before an audience of ladies at New Bedford.

February 11, Professor Chandler repeated the non-technical lecture on "Chemistry" at the residence of Mrs. C. B. Alexander, under the auspices of Columbia University.

March 13, he delivered a lecture on "Silk, Natural and Artificial" before the Sheffield Chemical Society at Yale University. This lecture was repeated at the Chemists Club, N. Y. City, June 10, 1908.

April 10, Professor Chandler lectured on "Electrochemistry" before the Local Section of the American Chemical Society at Union College, Schenectady, N. Y.

On March 10, Professor Pellew delivered an address to a gathering of people interested in the Arts and Crafts movement upon "Artificial Dyestuffs" at the studio of Mrs. Frederick Richardson. He also delivered a series of three public lectures for the Board of Education upon the "Application of Modern Dyestuffs to the Textile Fabrics," and is now preparing a series of eight articles to be published in the *Craftsman*, beginning with the June number upon the use and application of modern dyestuffs in Arts and Crafts work.

For more than a year Professor Pellew and D. W. Whipple, '08, have been engaged in a research upon the manufacture of solid tetrachloride of tin in a commercial form. In the course of their investigations they have worked out a new catalytic process involving some novel ideas which may have considerable practical value. They have been granted a patent on their process in the United States and have applied for patents both in Europe and in Canada.

Professor Bogert has been elected president of the Chemists Club of New York and reëlected to the presidency of the American Chemical Society. He is also a member of the Committee on Conservation of our Natural Resources recently appointed by the American Association for the Advancement of Science, and by invitation of President Roosevelt became a member of the conference on this subject held at the White House, May 13–15.

At the general meetings of the Americal Chemical Society held under Professor Bogert's presidency, one at Toronto during the summer, and

the other at Chicago last December, several papers were presented embodying the results of researches conducted in the organic laboratory and at the Chicago meeting, Professor Bogert gave his presidential address on "American Chemical Societies." In December he lectured on "Stereochemistry" before the Eastern New York Section of the American Chemical Society at Union College, Schenectady, N. Y. He is the editor of Organic Chemistry for *Chemical Abstracts*, and his staff of abstractors includes the following officers and students of the department. Dr. V. J. Chambers, Dr. A. Hoffmann, Dr. K. G. Falk, Clarence H. May, F. L. Jouard, and A. Kropff.

Professor J. Livingston R. Morgan has charge of chemistry in the Summer Session. In the summer of 1907 twelve courses in chemistry were given with a total registration of 257, an increase of 93 over the registration of any previous year. The registration in chemistry as compared with the total registration of the Summer Session also increased from 6.82 per cent. in 1906 to 7.54 per cent. in 1907.

Professor Sherman has served during the year as chairman of the New York Section of the American Chemical Society and as president of the Society of Physiological Chemists. In February and March he delivered five public lectures upon the chemistry of nutrition and the factors affecting the nutritive values of foods.

Professor Tucker during the past year has added several pieces of apparatus to the equipment of the electro-chemical laboratory including vacuum electric furnace, induction furnace, double acting Geryke vacuum pump electrically operated, Abbe pebble mill, and low-pressure blower electrically driven. He has conducted a number of investigations in electrochemistry and has patented a process for making massive boron carbide.

Dr. Chambers lectured before the Summer School on the "Laboratory vs. the Plant," and repeated this lecture in December before the Cooper Union Chemical Society. He also addressed the Chemistry Teachers Club of New York on "Secondary Teaching in Chemistry from the Standpoint of the College." He has been appointed Supervisor of Examinations for the College Entrance Examination Board's examinations at Columbia in June, and is the Chief Reader in Chemistry for these examinations.

The bibliography of publications from the department including other publications than those listed as Havemeyer Contributions has been published in the Columbia University Quarterly.

C. F. C.

DEPARTMENT OF ELECTRICAL ENGINEERING.

(From Annual Report of the Head of Department for the year 1907-08.)

During the year one storage battery consisting of two large cells of 1,000 ampere-hours capacity each, and one storage battery consisting of 40 cells of 24 ampere-hours capacity each, have been installed in the instrument laboratory, as well as a heavy current generator for charging the batteries. These are available as general sources of cur-

rent but are particularly employed in the calibration of voltmeters, ammeters, wattmeters and other instruments for which a very steady current is desired. A number of new and improved measuring instruments, including portable standards designed especially for testing consumer's meters, have also been added to the departmental equipment. Under this head should also be noted the construction and calibration of a new and convenient form of instrument for measuring magnetic permeability and hysteresis as well as a series of condensers for use in connection with electrostatic voltmeters for measuring high potentials.

A collection of many recent forms of arc and incandescent lamps has been added to the departmental museum making this exhibit large and up to date.

Electrical circuits have been installed between the machine and instrument laboratories so that electrical machinery operating in the basement can be controlled from the instrument laboratory when the power is being employed for meter calibrations and other work.

The arrangement between the University and Department of Water Supply, Gas and Electricity of the City of New York (for electric meter testing) has been continued during the past year and Mr. A. E. Seelig, E.E., '07, under the direction of Professor Sever, has carried on the work. The number of meters tested during the year has been 260 and the results are transmitted to the city department for subsequent report to the consumer.

This work is very important in itself and serves also as a stimulus in the development of the instrument laboratory.

A very complete switch-board for controlling and testing alternating current machinery was completed and used during the past year and greatly facilitated the experimental work of the students.

An ondograph, presented to the department by Mr. Mailloux, enables the form of alternating current waves to be quickly and conveniently traced. This also materially facilitates the very important but somewhat difficult laboratory instruction in this direction.

On account of the increased requirements in electrical engineering for civil and mining engineering students, the lecture rooms and laboratories will be more crowded during the present year than heretofore. The total number of students to be provided for and the number of hours of instruction given to them will be considerably increased. To avoid difficulty on this score so far as possible, all laboratory courses have been laid out for the entire year so that each of the squads of students into which the classes are divided, will know exactly what experiment is to be performed on each day throughout the course. This complete systematizing of laboratory practice appears to be the best solution of the problem, especially when large classes and many different grades of instruction are involved.

The increased demands upon the laboratory facilities will also necessitate the carrying on of some of the photometric work at night, which fact in itself is very significant of the conditions to be faced in the future.

Stanley F. Bond, E.E., '07, who served as assistant in the department during the past year has been promoted to the position of tutor

in electrical engineering which was made vacant by the resignation of Dr. E. S. Downs.

Hanford C. Adams, A.B., E.E., and James E. Wilson, Ph.B., E.E., both electrical engineering graduates of the class of 1908, have been appointed assistants in electrical engineering. The three gentlemen named and the three permanent officers complete the teaching force of the department.

FRANCIS B. CROCKER.

DEPARTMENT OF GEOLOGY.

The annual field session, long called the summer school, of the department of geology was this year held at Port Henry on Lake Champlain with a party of fifty. A week was passed in the study and mapping of the district and the trip proved to be one of more than ordinary interest. At Port Henry the foothills of the Adirondacks come boldly down to the lake and consist of the ancient crystalline rocks. Resting upon them are the early fossiliferous strata of the Cambrian and Ordovician periods. Six miles back in the hills are the great iron mines of Mineville, where the first summer school in mining was conducted by Professor Munroe in 1878. The geology of the great ore-bodies proved of special interest to the class and many courtesies were extended by Witherbee, Sherman & Co., the largest of the present operators in the region. The return trip was through Lake George. Professor Kemp, Professor Grabau and Dr. Berkey were in charge and the first named took especial pleasure in conducting the party over a region upon which he had been engaged in field work ranging over twenty years.

Later in the summer Professor Kemp went west as the guest of Kingdon Gould, '08 Mines, and with a party consisting of Kruse, '07, Estee, '08, Danehy, '08, and Espinosa, formerly '08. Bingham and Tintic, Utah, Ely, Nev., and later Guanajuato, Mex., were visited and many interesting and instructive observations were made. At Bingham and Garfield numerous courtesies were extended by the officers of the Boston Consolidated and Utah Copper Companies. The party found Dresser, a graduate student in '05, in the mill of the Boston Con. and were shown around by him. In Tintic everything possible was done in the way of entertainment by McCaffery, '96, and Riter, '99, and in Salt Lake City by Ernest and Sidney Bamberger. In Ely, Berry, '05, was very good to the party and under his guidance the low-grade mines were very profitably visited. While the younger members of the party were in Park City and Castle Gate, Professor Kemp made a week's detour into the region west of the Salt Lake basin and along the Utah-Nevada line where much interesting geology was seen. After a long railway trip through El Paso and down the Mexican Central, several weeks were spent in Guanajuato where the party met Fisher, '05, Fulton, '06, and Clark, '07, and saw much of the mines.

Professor Grabau conducted a party of graduate students as a field course in June and July, up the Hudson Valley, westward to Buffalo, and south to Pittsburgh. They passed from the most ancient strata to the Coal Measures and gained a wide stratigraphical experience. From

a creek west of Buffalo, they secured and shipped to the university a single fossil coral, of about 800 lbs. weight.

Dr. Berkey was chiefly occupied during the vacation with work for the state geologist and for the Board of Water Supply of New York City. A bulletin for the former based upon the geological problems met by the latter is in active preparation. Edwin Kirk, assistant in the department continued his work in the State Geologist's office upon a report which will deal with the crinoids of New York.

A. C. Boyle, Jr., university scholar in geology, passed the summer in the employ of the Bully Hill Copper Mine, California, preparing a geological map for the company.

J. E. Hyde, fellow in geology the last year, has been appointed assistant in physiography at Harvard, for a half year and will later continue work upon his dissertation for Ph.D.

DEPARTMENT OF MECHANICAL ENGINEERING.

(From Annual Report of the Head of Department for the year 1907–08.)

The following is a brief report on the activities of the department of mechanical engineering for the past year, touching only on such phases of it as seem to be of general interest.

In conjunction with the adoption of the new course of study in the department there have been organized throughout, improved methods of instruction for the better teaching of the subjects as well as a revision of the subject-matter itself, involving the elimination of obsolete material and the substitution of strictly modern data. For those courses which have become specialties in the profession special and expert lecturers have been secured to serve without pay. Scrap books, containing cuts and tables relating to modern machinery not found in text-books, are being prepared for distribution to the students. A fairly complete working library of commercial literature, professional papers, blue prints, drawings and pictures has been established and this material will be used by the students for consultation in the library or at home. In class room, laboratory and drafting room the new methods of instruction have the common aim of training the the students to think clearly and independently rather than of memorizing a large number of isolated facts easily forgotten, and in this connection students are permitted to use text and note books at all examinations. In some of the courses, especially that on steam power machinery where next year's class will contain nearly 300 and in technical thermodynamics nearly 200 men, instruction by the lecture system must necessarily be ineffective, but classes of such sizes cannot be taught by the recitation method without sub-division. It is hoped that the department will make such progress that the addition of one or two members to the staff will be possible next year so as to eliminate entirely all purely lecture courses. To reduce the bad effects of this lecture method, numerous problems will be given out in the lecture and written quizzes held, but the correction of these problems and quiz books is going to be a burden on our small staff as the lecturer can give but little personal attention to it by reason of a total of sixteen hours' lecture assignments in the second term.

It is a matter of some importance to note that everyone of the officers of this department during the past year was engaged in professional work of a high order, but that the time consumed was not prejudicial to the instruction. It is very necessary to maintain this professional practice idea so as to prevent our instructors drifting too far away from present-day requirements.

Throughout the year regular bi-monthly meetings of the instructing staff in the department were held for the discussion of all the problems of the department, executive, financial, educational and disciplinary, and judged from the results obtained the practice is a good one as it has a tendency to promote team work and a sense of responsibility for the department's success.

An organization of the graduates of the department has been effected, and at the three or four regular meetings of each year the progress of the department will be discussed, ideas secured and social intercourse between men who ought to be close together, stimulated.

Numerous complaints from students concerning their inability to secure books listed in the general library, but lodged in departmental libraries, indicates a necessity for a change of practice. In order to set an example the department has turned over to the general library all books in the departmental library and will not in the future receive any books from the general library unless there are two copies, one of which may be kept there. In addition there has been turned over to the general library a large number of books, the property of the department, which were received from the estate of former Professor Trowbridge.

C. E. LUCKE.

DEPARTMENT OF METALLURGY.

For the Summer School in Metallurgy of Iron and Steel a fortnight was spent visiting the works in and around Pittsburgh. One week was spent in Non-Ferrous Summer School visiting plants in the neighborhood of New York, about thirty students attending.

In the University Summer Session a course in metallography was well attended.

R. F. Böhler of Kapfenberg, Styria, a student in the department, was awarded a Carnegie Research Scholarship by the Iron and Steel Institute of Great Britain. Professors Howe and Campbell were appointed on the board of editors of the new *Journal of Industrial and Engineering Chemistry*.

There have been some changes in the courses of instruction. Professor Walker is giving the lectures in lead, gold, silver, etc., Professor Campbell transferring his work to iron and steel. Dr. Kern has added to his course on copper by an introductory course of lectures on general metallurgy.

During the summer vacation Professor Walker paid a professional visit to Idaho and on the return trip visited the cyanide plants at Colorado City and the lead smelters of the southeastern Missouri district.

Dr. Campbell joined the Canadian Mining Institute and their European guests in a trip to Nova Scotia, where the collieries and iron

and steel plants of the Dominion Coal and Iron Companies and the Nova Scotia Iron and Coal Company were visited.

A. L. W.

DEPARTMENT OF MINERALOGY.

(From Annual Report of the Head of Department for the year 1907–08.)

The equipment has been improved, especially by the addition of electric furnaces for working at known temperatures. Also convenient sets of bottles have been arranged containing liquids for the microscopic determination of refractive indices.

The student collections have been increased, by the creation of a small collection arranged on the systematic instead of the economic order, and the grade of the specimens improved.

A systematic laboratory guide has been prepared, giving for each course, the order of work, the description of the tests, and the necessary text-book references. In general, also, a course has been divided into periods and the required work of the period and form of examination at the end of it have been stated. Lists of examination questions have been appended.

A third revised edition of Professor Luquer's "Minerals in Rock Sections" has been published and the fourth edition of Moses and Parsons's "Elements of Mineralogy," is in preparation.

Mr. C. A. Stewart, the assistant in mineralogy since 1906, has been appointed an instructor at Cornell University and his place filled by Mr. G. S. Rogers.

A. J. M.

DEPARTMENT OF MINING.

Mr. Edward Lawrence Kurtz, Instructor in Mining, has been appointed Adjunct-Professor, his promotion taking effect July, 1, 1908. Dr. Walter R. Crane, for the past three years instructor in mining, resigned his position at the end of the last college year, to take charge of the Mining Department of the Pennsylvania State College. The post thus vacated has been filled by the appointment of Edward Knight Judd, B.A., E.M. Mr. Judd graduated from Williams College in 1901, and from the School of Mines with the class of 1903.

During the summer vacation Professor Munroe has been engaged in field work for the St. Lawrence Pyrites Co., St. Lawrence Co., N. Y. Professor Peele was occupied in June and July in making examinations of gold properties in South Carolina and Nevada. A book entitled "Compressed Air Plant for Mines," by Robert Peele, was published by John Wiley and Sons on September 1.

The Hardsocg Wonder Drill Co., Ottumwa, Iowa, has kindly presented to the Department of Mining one of their thirty-pound compressed air hammer drills, designed for mining work.

Summer Class in Mining.— During the past summer 39 students have been engaged in mining field work. One division of the class, composed of H. V. Baldwin, W. R. Bamber, P. W. Gaebelein, E. H. Leslie, T. S. Syverson, W. M. Thompson, and W. W. Tonking, was

in charge of Dr. W. R. Crane. This party spent five weeks at the extensive mines of the Federal Lead Co., Flat River, Mo., where the usual detail work of note-taking and sketching was done. A sixth week was devoted to studying the mining and milling methods of the Granby Mining and Refining Co., Joplin, Mo., followed by a short visit to neighboring mines. The work began on June 12 and closed July 23. Excellent facilities for observation and study were afforded by the officers of these interesting mining properties.

Of the remainder of the class, eighteen men, in squads of from two to four, made independent trips, generally ranging in actual working length from seven to eight weeks, in some cases ten weeks. These squads were organized as follows: R. Annan and T. Earle studied at the Wolverine and other copper mines, on Keweenaw Point, Mich., visiting afterwards the Vermilion and Mesabi iron districts; G. A. Blow, L. E. Grant, F. W. Moore and S. L. Landon, at the mines of the Yak Mining, Milling and Tunnel Co. and others, Leadville, Colo., followed by a visit to the gold mines of Cripple Creek; T. B. Farrington, H. E. Hall, D. G. Miller and W. W. Cutler, Jr., at the Silver Bow mine, of the Anaconda Copper Co., Butte, Mont., preceded by a trip to the Mesabi iron region; E. R. May, H. W. Kitson and G. L. Helmrich, at the Golden Reward, Mogul and Homestake mines, in the Black Hills, S. Dak.; H. S. Kohlberg and R. T. Hirsh, at the Bisbee and Cananea copper mines and the Tombstone, Ariz., silver mines; P. E. Locke and W. B. Mucklow, at the mines of the Tennessee Copper Co., Ducktown, Tenn. Also, H. A. Fuld studied in the Butte, Mont., district from June 13 to August 25.

Three students, G. W. Danehy, K. Gould and L. M. Kozminsky, fulfilled by additional study the requirements in mining field work. J. A. Battle, Jr., G. B. Holderer, E. B. Latham, G. W. Roddewig and F. B. Tough, who had partial credit for field work and study, made special trips for additional note-taking and sketching, under arrangement with the department.

The following men, under leave of absence, have studied or worked as miners for considerable periods during the past year: M. B. Gentry was engaged at several Arizona mines from October, 1907, to May, 1908; C. L. Bruns, Jr., and G. M. Richards worked, chiefly underground as mucker, miner, timberman, etc., for about twelve months, in the Center Star and War Eagle mines, Rossland, British Columbia, and in the Cœur d'Alene district, Idaho; T. K. Scott occupied a position for nearly a year at the Cumberland-Ely copper mine, Nevada; J. J. Wolfersperger worked two months in the War Eagle mine and nearly three months in the St. Eugene mine, Moyie, B. C.; A. L. Stillman, in connection with a position at Scranton, Pa., studied in some of the neighboring anthracite collieries.

On the whole, as shown by the note-books, the work done by the class was satisfactory. Special mention may be made of the excellent sets of note-books brought back by Messrs. Gentry, Helmrich, Kitson, Miller and Scott.

R. P.

ANNUAL MEETING OF ALUMNI ASSOCIATION.

REPORTS OF OFFICERS OF ALUMNI ASSOCIATION SUBMITTED AT THE ANNUAL MEETING HELD AT COLUMBIA UNIVERSITY, APRIL 30, 1908.

REPORT OF SECRETARY.

Total membership April 25, 1907		1020
New members:		
Class 1907	90	
All others	7	
	97	
Deceased	7	
Resigned	6	
	13	
Net increase		84
Total membership		1104

R. E. MAYER,
Secretary.

REPORT OF TREASURER.

The Alumni Association of the Schools of Science of Columbia University in account with W. M. Fellowes Morgan, Treasurer:

DR.

Balance on hand, April 19, 1907	$2,157.47
Received from R. E. Mayer, Secretary, on account dues collected	1,944.35
Interest on deposit in Irving Savings Institution Jan. 1, 1907–Jan. 1, 1908	24.52
Total	$4,126.34

CR.

By Payments.	
Collation at annual meeting and Commencement	$ 320.40
Clerical work and typewriting	96.32
Printing and stationery	112.50
Alumni lists printing	570.00
" " postage	60.00
Columbia University Quarterly	250.00
School of Mines Quarterly	1,128.75
Alumni Council, Columbia University, dues for year ending October, 1908	50.00
Arrears of dues in full	150.00
Balance on hand April 30, 1908	1,388.37
	$4,126.34

Balance distributed as follows:

Irving Savings Institution	$ 632.22
Market and Fulton National Bank	756.15

E. & O. E.

W. FELLOWES MORGAN,
Treasurer.

SUMMARY OF THE ACCOUNT OF THE BUSINESS MANAGER, SCHOOL OF MINES QUARTERLY: JANUARY 1, 1907, TO APRIL 1, 1908.

	Disbursements.	Receipts.
Balance on hand January 1, 1907		$1,198.93
Alumni Subscriptions		1,128.75
Other Subscriptions		243.28
Advertisements	$ 64.73	708.98
Back numbers and reprints		331.83
Exchanges	9.60	104.91
Editorial	550.00	
Illustrations	307.80	
Printing	1,949.67	
Postage	114.38	
Addressing Labor and Express	45.85	
Sundries	40.83	
Interest on bank deposits		7.64
Balance on hand, April, 1908	641.46	
	$3,724.32	$3,724.32

Balance distributed as follows:

Cash in Corn Exchange Bank	$115.19
Cash on hand	4.21
In Knickerbocker Trust Co.	522.06
	$641.46

T. H. HARRINGTON,
Business Manager.

BOOK REVIEWS.

Compressed Air Plant for Mines. The Production, Transmission and Use of Compressed Air, with Special Reference to Mine Service. By ROBERT PEELE. New York, John Wiley & Sons; London, Chapman & Hall, Ltd., 1908. 8vo, pp. xix + 325, 112 figures. Cloth, $3.00 (12/6 net).

Preface. — The increasing use of compressed air makes the subject of interest to practitioners in nearly all branches of engineering. Besides its more important power applications, such as the operation of rock-drills, air brakes, riveting machines and railroad switching and signaling systems, the uses of compressed air are numerous in many minor branches of mechanical engineering, in caisson work and the construction of subaqueous foundations, and in manufacturing industries, chemical works, etc., where it serves a multitude of purposes entirely distinct from that of the transmission of power.

A realization of the breadth of the field has suggested that a book may be acceptable, addressed especially to those who are engaged in mining, tunneling, quarrying, and other work involving the excavation of rock, with its concomitant operations. While the literature bearing upon this branch of compressed-air service is by no means small, it is for the most part scattered through the technical periodicals and transactions of engineering societies, and therefore not readily accessible to those who are out of convenient reach of engineering libraries. I am aware that little that is new can be said on this subject, and in writing the book I have availed myself freely of existing sources of information.

In the first part, I have endeavored to present a view of current practice as to the construction and operation of compressors. Portions of the subject are dealt with at some length, such as: the types of compressor suitable for different kinds of service, heat losses occurring in air compression, and the various forms of valves, valve-motions, and governing and unloading mechanisms, that constitute prominent features of modern compressor practice. A brief review is given of a few of the fundamental principles of air compression, but my intention has been to present only enough of the theory to make intelligible the formulas employed for the ordinary calculations of the power and capacity of compressed-air plant, together with the questions concerning temperature changes, as affecting the production and use of compressed air. Many details of the design of compressors and proportions of their parts have been omitted, since these fall properly within the province of the mechanical engineer. The second part is devoted to the applications to mine service of compressed-air transmission of power; including machine drills, pumps operated by compressed air, and mine haulage by compressed-air locomotives.

Many of the illustrations are reduced or adapted from working drawings kindly supplied by compressor builders. Others have been taken

from catalogues of compressed-air machinery and from technical periodicals and books dealing with the different types. The origin of these has been stated in nearly every instance. My thanks are due to several of the technical journals, especially *Compressed Air Magazine* and *Mines and Minerals*, for many suggestions and in some cases for passages extracted either in substance or verbatim, from articles therein contained. For any important use of or adaptation of published material, permission has been asked and obtained, and frequent references are given in foot-notes or in the body of the text. I also wish to acknowledge my indebtedness to Mr. Frank Richards's book on "Compressed Air," from which I have derived substantial assistance.

Abstract of Contents. — Part First: Production of Compressed Air — Preface, List of Illustrations. Chapter I.: Introduction, Development of Air Compressors, Compressed Air *versus* Steam and Electric Transmission of Power. Chapter II.: Structure and Operation of Compressors — Straight-Line and Duplex Compound Steam End, Stage Compressors, Direct- and Belt-Driven or Geared Compressors. Chapter III.: The Compression of Air — Outline of the Theory. Chapter IV.: Wet Compressors. Chapter V.: Dry Compressors. Chapter VI.: Compound or Stage Compressors — Theory and Operation. Chapter VII.: Air Inlet Valves. Chapter VIII.: Discharge or Delivery Valves. Chapter IX.: Mechanically Controlled Air Valves and Valve Motions. Chapter X.: Performance of Air Compressors. Calculation of Horse-Power of Single-Cylinder and Stage Compressors. Chapter XI.: Air Receivers. Chapter XII.: Speed and Pressure Regulators for Compressors — Air Cylinder Unloaders. Chapter XIII.: Air Compression at Altitudes above Sea-Level, Relation between Compressor Output and Barometric Pressure. Chapter XIV.: Explosions in Compressors and Receivers. Chapter XV.: Air Compression by the Direct Action of Falling Water.

Part Second: Transmission and use of Compressed Air. Chapter XVI.: Conveyance of Compressed Air in Pipes. Chapter XVII.: Compressed-Air Engines — Working at Full Pressure or with Partial or Complete Expansion. Chapter XVIII.: Freezing of Moisture Deposited from Compressed Air. Chapter XIX.: Reheating Compressed Air. Chapter XX.: Compressed-Air Rock-Drills. Chapter XXI.: Operation of Mine Pumps by Compressed Air. Chapter XXII.: Pumping by the Direct Action of Compressed Air — Pneumatic-Displacement Pumps, Pohlé Air-Lift Pump — Theory and Operation. Chapter XXIII.: Compressed-Air Haulage for Mines — Construction and Operation of Compressed-Air Locomotives.

Lead and Zinc in the United States. Comprising an Economic History of the Mining and Smelting of the Metals and the Conditions which have Affected the Development of the Industries. By WALTER RENTON INGALLS, Editor of the Engineering and Mining Journal, Mineral Industry, etc. Hill Publishing Company, New York, 1908. Pp. x + 368. Price $4.00.

As the author states in his preface, this book was prepared at the request of the Carnegie Institution of Washington to form part of the

Economic History of the United States, which is to be published by that institution. It therefore deals almost entirely with features which have been essential in the development and progress of lead and zinc mining and metallurgy in this country.

Part I., which is devoted to lead, commences with a brief description of the occurrence of lead ores, dwelling particularly on the important part that the Missouri district has played in the production of lead in this country. Chapter II. is a chronology of the history of lead mining which will be found most useful for reference and reminds us of some things we had long ago forgotten.

The development of the lead industry and the progress made in its metallurgy is then considered and forty pages are devoted to a review of this subject, commencing with the most primitive form of lead furnaces used, the log and ash furnace of Missouri, and ending with a description of the modern plant of the American Smelting & Refining Company at Murray, Utah.

Chapter IV. deals with the refining, marketing and uses of lead. Then follows, in Chapters V. to XII. inclusive, a general review of mining and metallurgical operations in different states and gives an interesting description of what has been accomplished in the development of this industry from time to time. The early discoveries and conditions are given in detail and make the work what it aims to be, historical. This is so interesting that we can forgive a few repetitions which occur but which, however, serve to impress facts on our minds.

Chapters XIII. to XVII. deal with statistics of production, consumption and price, commercial conditions, the tariff, labor conditions and trade agreements, a total of about sixty pages and give a vast amount of useful information. A table on page 201 shows the production of lead by years since 1821. What Mr. Ingalls says in conclusion in regard to the tariff on page 227 is concisely stated and appears to us to be sound.

Part II. takes up the history and metallurgy of zinc, beginning with the occurrence of these ores in the various states. Chapters XX. to XXII. consider the mining, dressing and smelting of zinc ores and give the progress made along these lines from time to time. Chapter XXIII. is devoted to statistics of zinc in the same manner as lead is treated in a former one.

The book is exceptionally well-edited and the paper and printing are excellent. It is issued in the regular form recently adopted by the Hill Publishing Company. The index is a most comprehensive one and enables us to turn at once to any desired subject.

A. L. W.

Tables of Minerals, Including the Uses of Minerals and Statistics of the Domestic Production. By SAMUEL LEWIS PENFIELD, LL.D. Second Edition. New York, John Wiley & Sons, 1907. 8vo, pp. vi + 88. $1.00.

The late Professor Penfield, of the Sheffield Scientific School, printed the first edition of this little book in 1903 evidently to supplement the

text-books there used by tables useful from the economic and determinative standpoints. In the new edition prepared by W. E. Ford, his successor, the economic statistics are brought up-to-date and the portion relating to geological occurrence and association is rewritten and enlarged.

The tables now contain: I., Arrangement of species according to crystallization. II., Arrangement of species according to the basic elements and their uses and statistics. III., Useful minerals, supplementing No. II. IV., Lists of minerals according to geological occurrence and association.

A. J. M.

A Pocket Handbook of Minerals, designed for use in the field or classroom with little reference to chemical tests. By G. MONTAGUE BUTLER, E.M., Assistant Professor of Geology and Mineralogy, Colorado School of Mines, Golden, Colorado, United States Deputy Mineral Surveyor. New York, John Wiley & Sons; London, Chapman & Hall, Limited, 1908. 16mo, pp. ix + 298. 89 figures. Morocco, $3 (12/6 net).

This book is designed for both field and class work and to fill a space between works "too cumbersome" for the field and works "so condensed as to confuse rather than aid."

Two hundred species are described in terms of those characters which the author considers best help in their determination, and preference is given to the so-called "physical features." Each species is described in the same fixed order and certain chosen characters are brought into especial prominence by the use of heavy-face type so that "a mere glance at a page will often suffice to recall the appearance of a mineral."

In the selection of important characters as indicated by heavy-face type, very great prominence is given to cleavage and very little to blowpipe or acid tests. It is certainly to be questioned whether in the field with average specimens, not usually crystals, even the trained mineralogist can determine more than the existence or non-existence of marked cl avage and in certain instances the approximate cleavage angles. The blowpipe is usually as available as the goniometer or microscope.

Following the descriptions of species which occupy 270 pages are some ten pages of miscellaneous tables including lists of commercially important ores, retail prices of cut gems, values of metals and minerals; then follows an admirable glossary in which, however, some of the fundamental terms, such as crystal, mineral and polarize, are not defined with scientific accuracy.

The tables which follow the index are summaries of the descriptions, characters in parallel columns and minerals in order of description.

The book is of convenient size for the pocket and embodies much easily accessible and useful information. In spite, however, of the fact that it is, as explicitly stated, designed for the determination of minerals, its value in the absence of all systematic schemes would seem to be rather to refresh the user's memory as to the characters of known or suspected minerals, than as a guide to the determination of unrecognized material.

A. J. M.

The Electric Furnace, Its Evolution, Theory and Practice. By ALFRED STANSFIELD, D.Sc. Published by the Hill Publishing Co., New York; and by The Canadian Engineer, Toronto, Canada, 1908. Pp. 211, 6 × 9; 53 illustrations. Price $2.00 (8/6) postpaid.

The author states in the introduction that "it has been the author's purpose to trace the evolution of the electric furnace from its simplest beginnings, and to set forth, as briefly as is consistent with clearness, the more important facts relating to its theory and practice." "No attempt has been made to give a description of all the electric furnaces that have been invented, but rather to set forth clearly the fundamental principles of this form of furnace; to show its various uses; to indicate its limitations; and, if possible, to be of some assistance to those who wish to design electric furnaces, or to judge of the feasibility of schemes involving their use."

The author is deserving of congratulations, as he has not only succeeded in his purpose, in so far as the industrial electric furnace is concerned, but has also given the electrochemist and the electrometallurgist a most valuable and a much needed book on the subject, one which is a valuable reference book for the practitioner, and, as well, a suitable text-book for the student.

The title of the book is rather broad, as it does not really give the evolution of the electric furnace, but the evolution of the industrial electric furnace. This, however, does not detract the value of the book, as we already have Moissan's "The Electric Furnace" (translated by V. Leuber, 1904), which gives the evolution of the laboratory furnaces, in which experiments were conducted at high temperatures. We also have J. Wright's "Electric Furnaces, and their Industrial Applications" (1904), which, as the title suggests, is a compilation of information on the industrial application of the electric furnace. These three books, thus, furnish a fairly good library on the subject. Dr. Stansfield might have better titled his book "The Industrial Electric Furnace, Its Evolution, Theory and Practice."

There has long been need of an up-to-date book on the electric furnace, treating the subject from a practical standpoint. The author, appreciating this, has written an excellent, though condensed treatise. The book contains concise descriptions of most of the principal technical electric furnaces, together with valuable data, and calculations used in their construction and for their economical operation. In fact, we have been supplied with a very good book on the subject, one which is concisely and well written, and at the same time sufficiently elementary for a person who has not had the advantage of a university training. Other valuable features of the book are the foot-notes, and the numerous foot-note references to the original articles from which the text was taken. Also, a very complete index of seventeen pages affords a means of ready reference.

The book contains seven chapters, as follows: I. History of the Electric Furnace (pp. 1–14). The historical development of the electric furnaces, as applied for electo-chemicals and electro-metallurgical purposes, is given in condensed form.

II. Description and Classification of Electric Furnaces (pp. 15–

32). This treats briefly the application of the Ohm's Law and the Joule's Law to electric heating, and gives the essential parts and accessories of electric furnaces, as well as a classification and a description of type furnaces.

III. Efficiency of Electric and Other Furnaces and Relative Cost of Electric and Fuel Heat (pp. 33–47). Contains calculations and tables of net efficiencies of furnaces for melting metals, the melting temperatures of metals, the quantity of heat required to melt metals, the calorific power of fuels, and calculations of efficiencies and operating costs of furnaces.

IV. Electric Furnace Design, Construction and Operation (pp. 48–84). Includes refractory materials for furnace construction, tables of the melting points and heat conductivity of refractory materials, formulæ for calculating the E.M.F. necessary to operate electric furnaces, and calculations of the electrical resistance of resistors.

V. Production of Iron and Steel in the Electric Furnace (pp. 85–135). Describes the production of iron and steel in electric furnaces of the arc, the arc-resistance, and the resistance types. "The Report of the Canadian Commission on the Electro-Thermic Processes for the Smelting of Iron Ores and the Making of Steel" (1904) was used freely in preparing this chapter. General data, tables of slags, etc., and cuts of the principal furnaces are given.

VI. Other Uses of the Electric Furnace (pp. 136–188). The production of ferro-alloys, graphite, carbides, silicon, fused quartz, glass, alundum, nitric acid, phosphorus, carbon bisulphide, caustic soda, sodium, and aluminium, the electric smelting of zinc ores, and chlorine-smelting of sulphide ores are given.

VII. Future Development of the Electric Furnace (pp. 189–194). Considers the possibilities of the electric furnace, in the future, when electricity will be more cheaply generated by water power and by waste gases from the iron blast-furnace.

The impressions which one is apt to have after he has read the book are: the excellent arrangement of the topics, the large amount of valuable information and the concise form in which it is given.

The author in attempting to limit the size of the book has treated a number of the subjects too briefly, thereby doing himself an injustice. An instance may be cited which will make this evident. In Chapter VI., on page 174, the Taylor carbon bisulphide electric furnace was not described, merely mention being made that carbon bisulphide is made in an electric furnace and a brief description of its preparation. The Taylor furnace is considered one of the most successful industrial electric furnaces, and one, the principles of which are destined to be applied in the construction of electric furnaces for other purposes, such as the smelting of ores, etc. There are also other subjects which have been too concisely treated, which, had they not been so condensed, would have made the book more valuable. It is unfortunate that this was done.

The book, nevertheless, is an excellent one. It is well written, is printed in clear-cut type, and with exceptionally few typographical errors. It might have been improved somewhat by having better cuts of the

furnaces, which were not well executed; however, the drawings, though rough, and most of them not drawn to scale, clearly illustrate the general construction of the furnaces.

E. F. K.

Highway Engineering. By CHARLES E. MORRISON, A.M., C.E., Tutor in Civil Engineering, Columbia University. New York, John Wiley and Sons; London, Chapman and Hall, Limited, 1908. Cloth, 8vo, pp. 315, including index. Price $2.50. Fully illustrated.

The preparation of this work was evidently undertaken as a direct consequence of several years' experience in teaching the subject of highway engineering by the aid of one or other of the voluminous, but otherwise excellent, reference treatises on highway engineering now in general use, "with a view," as the author states in his preface, "to furnishing a text in which the fundamentals of the subject should not be buried in a mass of detail, such as is frequently found to be the case in works of a similar character." The author has carried out the idea embodied in the statement above with judgment and discrimination.

The work comprises ten chapters and a comprehensive index with cross-references. The first chapter, dealing with the topic of road resistances, very simply and clearly explains the underlying principles involved, the effect of the various physical factors to be considered, and the methods of determining numerical values for the resistances under varying conditions. Tables showing numerical values of tractive force under widely differing conditions of road surface, material, and inclination, and with varying speeds, are included, as are also several diagrams and illustrations, cóvering the subject-matter of the text.

Each of the remaining chapters is devoted to one special type of road or road pavement, the method of treatment in each case being clear and sufficiently comprehensive, considering the main purpose for which the book was written. While the text necessarily follows, in a general way, that of the best of our modern works on highway engineering, the omission of a large amount of detail — very important to the engineer, but unnecessary and confusing in the case of the student with limited time at his disposal — leaves the important matters unobscured; and in addition, many matters taken from current practice and from the records of recent investigations have been inserted, adding to its value. The reviewer, after several years' experience in teaching this subject from the larger works, welcomes this text-book of Mr. Morrison's, as being called into existence by the exigencies of teaching, and therefore filling a legitimate place.

A. B.

The Plane Table and Its Uses in Surveying. By W. H. LOVELL, Topographer, U. S. Geological Survey. New York, McGraw Publishing Co. Pp. 47. Price $1.00 net.

With the many highly satisfactory works already in print on the general subject of surveying, and containing as they do, considerable information as to the plane table, it would seem that the present little volume should be filled with a mass of detailed information on the subject if it is to justify its publication.

Such can hardly be said to be the case however, for in the something less than 47 pages of printed matter, the subject is handled in such a general way that it is scarcely suitable as a text for the student, while on the other hand it presents no new phases of the subject for the engineer.

For example, under the section, "Adjustment of the Alidade," directions are given for that of collimation in such a manner that it would be impossible for an inexperienced person to follow them intelligently, while for the engineer they are not needed.

Again, under the section "Three-Point Problem" instructions are given for making a stadia-rod, why it is difficult to see, in the following brief manner. "To make a stadia-rod, take a strip of smooth unpainted board, from four to six inches wide, and ten to fifteen feet long. Mark off the board into sections six inches in length and paint each alternate section black." It is safe to say that a stadia-rod made as crudely as directed above would speedily introduce errors due to warping, and the inability to hold it vertical.

The book treats in its brief way, the following topics: Forms of Plane Tables, Adjustment of the Alidade, Plane Table Triangulation, The Three-Point Problem, The Two-Point Problem, Centering the Plane Table Over the Station, Vertical Angulation, Signals, Land Surveys, Plane Table Traverse, Projections, and Conclusions.

C. E. M.

Curves for Calculating Beams, Channels and Reactions. By SIDNEY DIAMANT, E.E. New York, McGraw Publishing Co., 1908. Pp. 13, 25 plates.

This book contains a series of plates that will be of use to the structural engineer or architect in the determination of the beam and girder sizes required in buildings or other structures, where uniform loads per square foot are used. The plates are made to cover all loads and spans commonly used and not only make it easy to pick out the section required for a given condition, but have the more important quality of affording a rapid means of determining the most economical sizes to be used. There is also a series of plates for determining beam reactions.

S. O. M.

The Design and Equipment of Small Chemical Laboratories. By RICHARD K. MEADE. Chicago, The Chemical Engineer Publishing Company, 1908. Cloth, 8vo, pp. 144, 111 illustrations. Price $2.00 net, postpaid.

The chapter headings of this book are: General Features, Hoods, Sinks and Water Supply, Desks, Table and Apparatus for Rapid Filtration, Ignition Table and Apparatus for Ignitions, Table and Apparatus for Titrations, Balance and Accessories, Heating Appliances, Preparation of Distilled Water, Apparatus for Electro-chemical Analysis, Sampling Appliances, Assay Furnaces and Accessories, Miscellaneous Laboratory Equipment.

Much of the material presented was included in a series of articles published in *The Chemical Engineer* in 1905. The treatment is emi-

nently practical the author having even thought best to give in the text in connection with almost every description of apparatus, the name and address of some one firm from whom it may be obtained. The illustrations include in addition to the usual cuts loaned by manufacturers, some good line drawings showing the construction and arrangement of laboratory appliances. The book will be especially useful to the man who having gained his training chiefly by working at a desk in a large laboratory finds himself called upon to decide the entire design and equipment of a small one.

H. C. S.

Rocks and Rock Minerals. By LOUIS V. PIRSSON, Professor of Physical Geology in the Sheffield Scientific School of Yale University. New York, John Wiley & Sons. 12mo, pp. v + 414, 74 figures, 36 plates. $2.50 net.

This attractive and accurate manual marks somewhat of a new departure in treating of the subject and one of increasing specialization. By adapting from geology, as generally conceived, the portions relating to the origin, forms and sculpturing of rocks; from mineralogy the detailed descriptions of the rock-forming minerals; and by combining both with the descriptive treatment of the rocks themselves a fairly definite branch of science is developed, parallel with geology and mineralogy and called petrology. The work before us covers this ground and coming from its author it is needless to say that it has been done with accuracy, care and a full command of the subject.

The book is divided into three parts, the first, Introductory and General Considerations; the second, Rock Minerals; and the third, the Rocks. In the first a brief definition and an outline of the subject, with its history and methods of study, are given and are followed by the general chemistry of the earth and its minerals. In the second part the minerals are treated with great thoroughness. Under each, composition, crystallography, physical properties and blow-pipe characters are discussed and always by one who has had wide experience in both field and class-room. Yet even here it is impossible to escape the need of previous training in crystallography and mineralogy because the very first mineral taken up is orthoclase, whose crystals of "monoclinic symmetry" and complicated twining cannot be otherwise understood. While this and other feldspars make up the most important group of minerals in the igneous rocks, they present in their crystallography and chemistry one of the most complicated problems in mineralogy, and one must pass up to them, for any thorough knowledge, through the gateway of mineralogy itself. Where to draw the line has no doubt been a puzzling question of whose difficulties the author has, no doubt, been well aware, since it is impossible to make these matters clear to a reader or student who has not had the necessary introduction. A detailed and excellent series of determinative tables of the minerals concludes this portion.

Part III. opens with a discussion of the general relations and origin of the igneous rocks, and presents a most valuable chapter which will be of special interest to the reader. Professor Pirsson brings to this subject a wealth of experience and passes in review many of the most interesting

themes in rock study. He draws freely upon the results gained by himself and colleagues in the development of the quantitative system of classification and in their endeavors to secure more accurate descriptive terms for textures. Some of the latter will be new to the general reader. Thus "grained" replaces "granular" for the textures of the plutonic rocks and the author supports the advantages of this change. Yet granular is not the only term in wide use and is indeed one of the most unsatisfactory since of all rocks a sandstone is most granular. Some will therefore question the need of a new term in an already overburdened branch of science.

In the treatment of the igneous rocks the deep-seated ones are first discussed and the surface flows last. This order has the advantage of placing in the student's hands at the outset, granite, a rock with which of all the eruptive types the average man is most familiar, but it has the disadvantage of putting before him on the side of origin and crystallization one of the most obscure problems. A teacher or writer is always confronted too, with this choice, whether to follow magmas of like composition through their several developments depending on physical conditions, as from the surface to the depths; or whether to group the rocks primarily on textures. Professor Pirsson chooses the latter method of treatment, and thus while gaining in some respects is at the disadvantage of treating the obscurer problems first and the simplest last.

The concluding chapters take up the sedimentary and metamorphic rocks, developing the theme along standard lines, since in these groups, more especially the sedimentary, there is little opportunity to vary the established groupings and arrangement.

The book is well illustrated with plates. Many are from polished slabs of rock and while these are prepared as well as possible, the inevitable flatness of relief makes them hard subjects for satisfactory results. The author endeavors to conscientiously follow out the promise of the preface to make the treatment megascopic; but no one can write of the megascopic characters of rocks without a rich experience with the microscope and without calling upon its aid for illustrations. Thus drawings from the microscopic slides are much more significant for granites, diorites and these types of rocks, since photographs of polished slabs do not look essentially different from those of coarser sandstones. Even the granite-porphyry on Plate 19, and its neighbor the syenite-porphyry look more like sandstones in the plates, than like eruptives. On the other hand the plates of field occurrence are of great value and bring home to the reader vivid pictures of the way rocks look in the field. They operate also to make the science a living, useful one in outdoor applications and not the study of a dead lot of specimens in a laboratory. This most important feature of the subject, Professor Pirsson has consistently and successfully kept before him and the influence of his valuable manual upon its readers ought to be strong in making of them, individual observers.

J. F. K.

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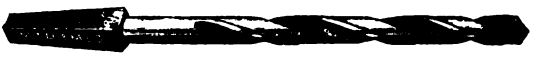

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SAMPLING AND ASSAYING THE COPPER ORES OF THE ELY DISTRICT.

BY ROBERT MARSH, JR.

The ores of the Nevada Consolidated Copper Company and the Cumberland-Ely Copper Company are large bodies of porphyry and altered lime impregnated with the sulphide and oxide copper minerals together with some native copper. The ore has been formed by the leaching of the overburden or capping and the secondary enrichment of the deeper zone. The line of demarkation between capping and ore is readily discernible because of the abundance of iron oxides and copper carbonates appearing in the former. This boundary is in many places very irregular, due to faulting and crumpling of the district.

Churn drills of the "Keystone" and "Star" type were extensively employed in prospecting. As these drill holes were sunk, the sands and cuttings, were pumped up and caught in wash-tubs for each five feet of depth drilled in the ore zone. Each of these representative samples was dried, coned and quartered, and sent to the assayer. Few of the holes exceeded 500 feet in depth and as a whole the ground was not difficult drilling. From this work much valuable information was acquired as to the likely location, thickness, extent and value of the ground; one company having thus developed about 15,000,000 tons of milling ore.

The result of this work was shown by platting the drill holes on the claim map, in conjunction with an ideal sectional map of all the holes correspondingly lettered. The sectional portion of the map was drawn to a much larger scale; and the elevations of

the tops of the holes taken from a common datum plane; these elevations, the five-foot assays and the depth of the holes accompanying.

Although some companies in the district have done a considerable amount of prospecting at depth by means of vertical shafts — work probably done before the advantage of drilling was locally appreciated — drilling has found much favor because of satisfactory results obtained cheaply and rapidly. The cost of drilling ranges from about $1.00 per foot in very favorable ground to $2.00 in ground of difficult character, with an average of about $1.50 in fair ground. The rate of advance will average from 20 to 25 feet per day in fair ground. A few typical examples may be of interest:

Hole No. 1. — Time, 11 days; footage, 235 feet; total cost, $306.60; cost per foot, $1.30; conditions favorable.

Hole No. 2. — Time, 16 days; depth, 412 feet; total cost, $770.16; cost per foot, $1.86; good hole, standing well.

Hole No. 3. —Time, 14 days; depth, 230 feet; total cost, $537.28; cost per foot, $2.33. Trouble with crevices and fitchering.

The above costs include: labor, superintendence, tool-sharpening, oil, hauling water 2 to 3 miles, wood fuel, maintenance, repairs and casing where necessary. There were worked two 12 hour shifts per day, the drillers receiving $6.00 per shift and the helpers $4.05. Moving the drill is not included. Water and wood were expensive items.

The cost of two compartment prospect shafts in this district have ranged from $18.00 to $26.00 per foot to depths of 50 to 170 feet. The rate of advance is about 2½ feet per shift.

The value of such drilling work depends largely upon the care taken of the samples, the ability to save the cuttings (in fissured ground they are likely to be lost), and the judicious location of the drill holes.

Development work in the Ely district has been similar to that at Bingham, Utah, and other districts having large low grade ore bodies of like occurrence.

At the Eureka cut of the Nevada Consolidated Company stripping of the over-burden, which at present is about 70 feet thick, is being done by two steam shovels. A third steam shovel follows, mining a bench of the ore. Churn drill holes are put down in advance, loaded with black powder, and shot to shake up the ground and

facilitate the work of the shovels. Where the ore bodies lie too deep for stripping, as at the Giroux and Cumberland-Ely properties, the development work has been by drifts and cross-cuts driven from the development shafts. The latter company has blocked out the ore in squares of from 60 to 100 feet on a side. The principal drifts have been advanced as long as in ore and from these, vertical and 70° incline raises have been driven at intervals of about 100 feet until capping was encountered. At greater intervals winzes have been sunk and hand churn-drill holes to a depth of 25 to 35 feet have been put down.

It has been with this prospecting and development work that the Sampler has been concerned, for his duty has been the taking of samples at regular five-foot intervals on alternate sides of the drifts and cross cuts, at like intervals on right and left sides of the raises and winzes as they progressed. The ground for the most part being a soft decomposed porphyry, often even of a sandy character, permitted the use of a sample-pick for the taking of the samples. An even groove about 2 inches wide by 2 inches deep was readily cut down the face, the Sampler doing the cutting with the pick in the right hand and catching the cuttings in the left hand, or in a candle box, preferably the latter. A few places required the use of moil and hammer where hard, tough limestone occurred. In good ground from five to eight samples could be carefully taken per hour. Check samples were taken from time to time and seldom varied more than .2 to .3 per cent. from the first sample. A large number of check samples were found to average .2 of one per cent. copper from the initial samples. These results were posted on the development maps in their representative places and from these data were estimated the tonnage and value of the ore bodies developed.

At the conclusion of the development stage proper at the "Veteran" mine, production was begun. To keep well informed as to the grade of ore being mined from the various working places (as the method of mining is by the top-slice system, similar to that employed in the iron mines in the Ishpiming district, the ore was drawn from separate raises leading to the various stopes) an ore-sheet was drawn up showing daily the number of cars drawn from each raise or working-face, and the assay value of such ore. To keep track of tonnage from these stopes, metallic tags were conveniently placed at the raise chutes, and on every car of ore drawn

therefrom a tag was attached bearing the chute number. As the cars arrived at the station, the station-man removed the tags, hanging them on their respective hooks, and took from each car a grab-sample which was put in a large galvanized bucket bearing the corresponding raise number. At the end of the shift these tags were counted, checked by the tally-board at each raise, and redistributed. The sampling was done with a half pint cup, thus securing nearly the same amount of ore from each car. With many ores, such a method of sampling would likely prove unsatisfactory; but the uniformity of this low grade copper ore, the finely broken condition of the greater part of it, and the mixing it received in dumping into and drawing out of the chutes, gave samples agreeing quite closely with those obtained by the systematic sampling of the feed at the concentrating plant. For the month of August the variation was but .06 per cent. copper covering a shipment of some 18,000 tons of ore.

The station-man, at the beginning of the day shift, emptied the sample pails into canvass cement sacks properly tagged, and had them hoisted, to be delivered to the assay office. Here they were riffled with a Jones sampler and reduced by repeated crushing mixing, and riffling to about two pounds. The samples thus reduced were placed in large manila envelopes and dried in baking pans, placed on a hot-water heater in the boiler room. The expense of construction and fuel to maintain a drier was thus avoided. The dried samples were then put through 80 mesh sieve, put in pulp envelopes and delivered to the chemist.

As these ores were found to contain little or no interfering elements, such as salts of silver, zinc, nickel, etc., the potassium cyanide method was employed for the mine assays. The method of assay was as follows:

Two grams of the pulp were weighed out in a "copper flask" and digested at low heat with 12 to 15 c.c. of concentrated nitric acid until the oxide of nitrogen was expelled; then ½ to 1 gram — depending on the amount of sulphur present — of potassium chlorate was added to put the sulphur in solution. The heat was now increased (an electric hot plate was used) and the solution boiled to about 5 c.c.; at this point the ore was found to be well digested and all excess chlorine expelled; about 30 c.c. of hot water was added and the boiling allowed to continue for several minutes until all ferric sulphate, etc., was in solution. The flasks were

then removed and allowed to cool, when 75 c.c. of cold water was added and then 45 c.c. of aqua ammonia (made by mixing 1 part ammonia sp. gr. 0.90 and 1 part water), and thoroughly shaken. The assays were then titrated with a solution of potassium cyanide (22.25 grams per liter) in the presence of ferric hydroxide. If much copper be present in the assay, the hydroxide will have a greenish tinge, which upon nearing the end-point of the titration, becomes buff or reddish and this fact serves as an indicator. The titration is continued at intervals until the supernatant liquid is very faintly blue when the assay is filtered and the titration finished on the clear solution. With practice in the procedure, the filtration may be omitted and the end-point reached in the presence of the iron.

With some of the assays the percentage of iron may be so high that filtering becomes necessary and then the objection arises to the copper held back by the ferric hydroxide, even after careful washing. In this case the precipitate may be redissolved with a little hydrochloric acid, diluted, made alkaline as before, titrated, and refiltered when there will be but a very little copper remaining in the precipitate. To show about how much copper may be held by the precipitate, on an ore carrying from 10 to 20 per cent. iron, when the titration is taken very nearly to the end-point in the presence of ferric hydroxide, the following results on a few samples are given:

Test Number.	1st Titration Gave in Presence of $(Fe_2(OH)_6)$.	2d Titration on Filtrate Gave.	3d Titration on Redissolved $(Fe_2(OH)_6)$.	Total %.	% of Total Cu Held in $(Fe_2(OH)_6)$.
1	3.80% Cu	0.56% Cu	0.18% Cu	4.54	4.0 %
2	4.20 " "	0.00 " "	0.10 " "	4.30	2.3
3	2.82 " "	0.00 " "	0.08 " "	2.90	2.8
4	2.47 " "	0.25 " "	0.13 " "	2.85	4.5
5	3.20 " "	0.13 " "	0.13 " "	3.46	3.8
6	3.44 " "	0.18 " "	0.08 " "	3.70	2.2
7	3.52 " "	0.00 " "	0.15 " "	3.67	4.1
8	2.18 " "	0.00 " "	0.20 " "	2.38	8.4
9	2.51 " "	0.34 " "	0.13 " "	2.98	4.4
10	6.57 " "	0.00 " "	0.08 " "	6.65	1.2

The filtrate was allowed to drain thoroughly, but the precipitate of ferric hydroxide was not washed thereafter. It will be seen that in several of the tests, copper was held in the precipitate even when the titration appeared to have been finished before filtering. As a rule, the higher the percentage of iron in the assay, the greater was the amount of copper held back, as might be antici-

pated. The average of the above tests shows that the results obtained are .126 per cent. too low (unless the ferric hydroxide be redissolved), or that the precipitate holds back 3.4 per cent. of the total copper.

For work requiring no greater accuracy than this the method will be found much more rapid than where the copper is first deposited on aluminium foil, redissolved with nitric acid, and then titrated. Some of the pulps were run in duplicate by these two methods with the following results:

Test Number.	By Direct Titration.	By Deposition on Aluminium.	Variation.	Remarks.
1	5.32	5.13% Cu.	1st higher .19%	
2	1.42	1.37 " "	1st " .05	
3	5.90	5.97 " "	1st lower .07	High in iron.
4	3.93	3 84 " "	1st higher .09	

The average of the above shows the former method to give results .065 per cent. higher than the latter. This may be due to the many handlings the assay must receive when treated by the latter method thus causing losses. It was found necessary after the addition of the nitric, hydrochloric and sulphuric acids, to boil the solution of the ore almost to dryness in order to expell all nitrates and get the copper subsequently to be rapidly and completely deposited on the aluminium. Boiling "to dense white fumes of SO_3" is insufficient.

The cost of making estimations by the "direct" method was for a period covering about 1,000 tests as follows:

Working supplies	7 cents
Labor	23 cents
Total	30 cents

The working supplies include all chemicals, heat, etc.; the labor item includes an assayer at $125.00 per month, and a helper to do the bucking — by hand — at $2.50 per diem. From 25 to 30 assays were made per day, although as many as 50 have been run.

The cost of laboratory equipment for such work should not exceed $150.00. At the mine laboratory a series of the three-way stop-cock burettes were found very handy, doing away with all handling of the cyanide solution. An electric hot plate 18 by 24 inches with three degrees of heat was most convenient.

As the previous discussion has been based upon the ores of the Cumberland-Ely Company it may be of interest to note here the ex-

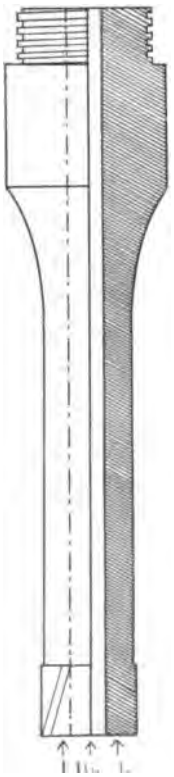
perience of Mr. Mark L. Requa, as stated in the Mining and Scientific Press of July 18, 1908, in connection with the ores and concentrate of the Nevada Consolidated Company. His article entitled, "Experimental Mill of the Nevada Consolidated Copper Company" is quoted from: "That, the result of some 150 assays made by the cyanide method, and compared with the same number from same pulp made by the iodide method showed a variation of 0.12 per cent., the iodide being the greater. Cyanide was found to be entirely satisfactory on low grade material, but upon the concentrate it was found that the results were erratic and always low, although in some cases the variation was very slight."

It is noteworthy that 0.126 was the average copper per cent. found to be held up by the ferric hydroxide — not far from the 0.12 per cent. higher results found by the iodide method.

NOTE ON DIAMOND DRILLING.

By CLARENCE M. HAIGHT, E.M.

Recently in putting in a diamond drill hole on the property of the Michigan Copper Mining Company, Rockland, Mich., a breakage occurred, that was dealt with in a peculiar manner, and, in view of the importance of diamond drilling as a means of prospecting, the following note may be of interest. The mode of procedure was original, in so far that no one connected with the drill work at the mine had ever seen or heard of a similar solution of the problem.



A nearly horizontal prospecting hole was being drilled from a point in one of the underground workings. The machine was a Sullivan, of the "H" type, taking out a one and one eighth inch core. The core-shell had become worn thin by use, so that, at a depth of 460 feet, it buckled under the working pressure of the rods and jammed in the hole.

The first step was to get the drill-rods out of the hole. Jack-screws were applied at the mouth of the hole to a gland bolted on the rods, sufficient strain being applied to break off the core-shell close to the core-lifter. It was found that the force required for this stretched the 460 feet of rods six inches. Next, the stump of core left in the hole had to be removed. As a chopping-bit could not be used for this purpose, without great risk of injuring the diamonds, a special tapering bit was made, as shown by Fig. 1. The larger end of this bit fitted closely enough in the hole to center and guide the boring end in grinding out the core. This done, the bit was replaced by a taper tap, with which the core-lifter was recovered.

Finally, a pointed drill (Fig. 2) was made of tool steel, properly tempered, and put on the rods. With this the remains of the broken core-shell, together with a portion of the original diamond

bit, were cut away until the bit itself was loosened in the hole. What was left of the bit, though only one inch long, was then easily recovered by a tap, and the diamonds were found to be uninjured. In using the pointed drill (Fig. 2), great care had to

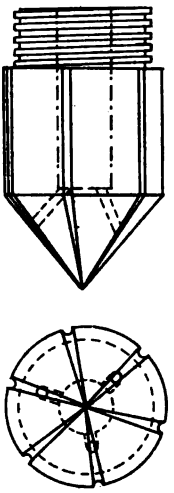


FIG. 2.

be taken to avoid running into the diamonds. To this end, the feed of the drill was accurately measured while the cutting was in progress. On recovering the bit it was found that there was still a margin of three eighths of an inch of steel above the first diamond.

THE EFFECT OF THE PRESENCE OF CERTAIN "ADDITION-AGENTS" UPON THE DENSITY AND THE COHERENCE OF ELECTROLYTICALLY DEPOSITED COPPER, LEAD AND SILVER.*

By ROYAL P. JARVIS and EDWARD F. KERN.

The addition of a small amount of certain reagents to electrolytes of some metals has the effect of altering the crystallization, the density, and the coherence, of the electrolytically deposited metal. In the arts, certain reagents are added to electrolytes for the purpose of improving electro-plates, and on a large scale, the technical electrolytic refining of lead is possible by the application of the same principle.

The "addition-agents" which have been found to cause electro-deposits of copper, lead and silver to form more dense, and more coherent, are the following:

A. *Copper Sulphate Electrolyte.* — A small amount of benzoic acid added to the electrolyte causes the copper to form as a more tough and a brighter deposit;† 10 grams of glue per liter of acid copper-sulphate electrolyte improves the deposit;‡ oak-wood tea, an extract of oak-wood, and which is composed chiefly of tannic acid, when added to the electrolyte causes the deposition of harder and smoother copper;§ the presence of hydroxylamine in the electrolyte gives a more coherent deposit of copper.‖

B. (*a*) *Lead Fluo-silicate Electrolyte.* — The presence of a small amount of gelatine, glue, pyrogallol, resorcin, saligenin, ortho-amido-phenol or hydroquinone causes the lead to deposit dense, smooth, and coherent, which if one of the reagents were not present, would form crystalline and non-coherent.¶

* Article based on an investigation conducted in the Metallurgical Laboratory of the School of Mines, Columbia University.

† *Metal Industry*, 1903, p. 179.

‡ *Trans. Am. Elect. Chem. Soc.*, VI., p. 33.

§ *Trans. Am. Elect. Chem. Soc.*, VIII., p. 83.

‖ *Trans. Am. Elect. Chem. Soc.*, VI., p. 29.

¶ Bett's "Lead Refining by Electrolysis," 1908, pp. 14, 15, etc.

(*b*) *Lead Nitrate Electrolyte.* — The addition of pyrogallol or hydroquinone to the electrolyte improves the deposit of electrolytic lead.*

C. (*a*) *Silver-potassium Cyanide Electrolyte.* — The addition of carbon bi-sulphide causes the silver to deposit harder and brighter.†

(*b*) *Silver Methyl-sulphate Electrolyte.* — The presence of a small amount of either carbon bi-sulphide, gelatine, or gum arabic, reduces the size of crystals of the electrolytically deposited silver, and also increases the coherency of the deposit.‡

(*c*) *Silver Nitrate Electrolyte.* — The addition of one part of glue, or gelatine, to 5,000 to 10,000 parts of electrolyte, restrains the large cathode crystals of silver, and increases their coherency.§

With these incomplete data as a nucleus, an investigation was planned and conducted for the purpose of determining whether the same "addition-agent" when added to different electrolytes has similar effects upon the electrolytically deposited metal. That is, if a certain "addition-agent" will improve the deposit of lead from a fluo-silicate electrolyte, will the same reagent improve or injure the deposit from an electrolyte of another lead salt? Also, will the deposit of copper and of silver from their respective fluo-silicate electrolytes, and as well, the deposits from electrolytes of other salts of copper and silver, be similarly affected by the same "addition-agent"?

It was thought, when the research was planned, that the effect which the "addition-agent" had upon the deposits might be attributed to certain characteristic chemical, or physical, properties of the "addition-agent"; such as, a characteristic radical, non-crystalline character, colloidal character, or else some other similar properties.

Abstract of Literature.

In reviewing the literature on this subject, it was found that very little had been systematically and scientifically done in this field. Most of the data found were such as seemed to have been accidentally acquired in the art of electroplating, and were given some-

* *Zeit. Electrochemie*, 7, p. 381, 1900; 9, p. 267, 1903.

† *Trans. Am. Elect. Chem. Soc.*, VIII., p. 83.

‡ Bett's "Lead Refining by Electrolysis," 1908, p. 166; *Elect. Chem. and Met. Ind.*, III., p. 145, 1905; *Trans. Am. Elect. Chem. Soc.*, VIII., p. 122.

§ *Trans. Am. Elect. Chem. Soc.*, VIII., p. 128.

what after this manner: A certain reagent added to a certain electrolyte improved, or else "sickened," the deposit. The literature on electroplating contains considerable data of this nature for producing dense, smooth deposits, but in most cases such data are so incomplete, or else so misleading, that the production of satisfactory electro-plates by following the methods as given, is generally a matter of chance.

The earliest systematic investigation of the effect of "addition-agents" in electrolytes, which was found in reviewing the literature, is that conducted by M. Kiliani in 1885.* He studied the effect of the presence of inorganic salts on the character of copper deposited from electrolytes containing 15 grams copper sulphate and 5 grams free sulphuric acid per 100 c.c. solution, when the current density at the cathode was up to 20 amperes per square foot. He noted the fact that the presence of a tin salt in the electrolyte caused the copper to deposit as a smooth, malleable sheet, whereas, when no tin salt was present, the deposit of copper was exceedingly rough and brittle. The electrical potential, required for the electrolysis, was markedly reduced when the anode contained tin.

The researches of Anson G. Betts, in the development of his electrolytic process of refining lead bullion,† were patiently and scientifically conducted, with the result of a successful electrolytic process for refining lead alloys. The process may be briefly outlined as the electrolysis of a lead fluo-silicate electrolyte, containing from 6 to 12 per cent. of lead and 7 to 15 per cent. of SiF_6, the base bullion being the anodes, and sheets of pure lead the cathodes. By having present in the electrolyte from one to two parts by weight of glue, or gelatine, per 5,000 parts of electrolyte, and by operating with a current density of 5 to 30 amperes per square foot and at a temperature of 15 to 45° C., the lead is deposited on the cathode as a dense, coherent, smooth mass of a purity of 99.99 + per cent. lead. The impurities in the bullion remain as "sludge" on the anode, and this "sludge" is subsequently treated by suitable methods for the recovery of the different metals, which it contains.

Not only is the deposit of metals effected by the presence of reagents in the electrolyte, but the temperature and the percentage

* *Berg und Huttenmann Zeit.*, 1885, p. 249.

† Betts, "Lead Refining by Electrolysis," 1908; *Trans. Am. Inst. Min. Eng.*, XXXIV., p. 175.

composition of the electrolyte, the circulation of the electrolyte, and the current density at the cathode, all have a decided influence on the character of the deposit. The investigation of Foerster and Siedel * may be cited to show what effect the temperature of the electrolyte has upon the properties of electrolytically deposited copper. They found that the deposit which formed, when the electrolyte was at 40° C., was of uniform fine-size crystals, and fairly ductile; when the electrolyte was maintained at 60° C., the crystals were larger and the deposit less ductile than when formed at 40° C. By operating with the temperature of the electrolyte above 60° C., the tensile strength of the deposit was higher than the deposits formed in electrolytes at lower temperatures.

Experiments conducted by Von Huebl † for the purpose of determining the effect of current density upon the tensile strength of electrolytically deposited copper, ascertain that both the tensile strength and the hardness of the deposited copper increased with the increase in current density up to about 28 amperes per square foot, independently of the percentage composition of the copper sulphate electrolyte.

A number of other references on the effect of current density, percentage composition and temperature of the electrolyte upon the properties of the deposited metal could be given, but as these references have no direct bearing upon the subject investigated, it is thought best to leave them out.

Experimental Part.

The electrolytes which were selected were:

1. Cupric Sulphate, Cuprous Chloride, and Cupric Fluo-silicate.
2. Lead Nitrate and Lead Fluo-silicate.
3. Silver Nitrate and Silver Fluo-silicate.

The "addition-agents" tried were:

(*a*) Gelatine, a complex protein material; the chemical arrangement of its constituents not entirely known; mainly an anhydride of amino-acids.

(*b*) Resorcinol, $C_6H_4(OH)_2$, meta-di-hydroxy benzene.

(*c*) Pyrogallol, $C_6H_3(OH)_3$; 1, 2, 3 tri-hydroxy benzene.

(*d*) Tannin, $C_{14}H_{10}O_9$; the arrangement of the radicals of this compound is not known; it may be consideted di-gallic acid, gallic acid being $C_6H_4(OH)_3 \cdot COOH$, tri-hydroxy benzoic acid.

* *Zeit. für Electro-chemie*, V., p. 508, 1899.

† *Mitth. des k. u. k. Militargeorge Inst.*, VI., p 51, 1886.

Preparation of the Electrolytes.

All of the electrolytes, with the exception of the fluo-silicates, were prepared by dissolving a known weight of the respective copper, lead and silver salts in water, adding a calculated amount of the respective acid, and diluting to such a volume as to give solutions which contained the desired amount of the respective metallic salts and of free acid.

The fluo-silicic acid (H_2SiF_6), which was used in preparing the fluo-silicate electrolytes, was made as follows: A measured volume of hydrofluoric acid, containing 40 per cent. HF, was placed in large platinum dishes, and a calculated weight of powdered quartz added in small amounts at a time, to prevent boiling of the solution. The amounts of hydrofluoric acid and powdered quartz were in the proportion expressed by the equation

$$6HF + SiO_2 = H_2SiF_6 + 2H_2O.$$

The combination produces sufficient heat to cause the loss of acid, should all the quartz be added at one time. When the reaction was complete, the solution was diluted to about two volumes, and the exact acid content determined by titrating a measured volume at a temperature of about 70° C. with standard potassium hydroxide solution, using a few drops of an aqueous solution of rosalic acid as the indicator. The end point of the titration is represented by

$$H_2SiF_6 + 6KOH = 6KF + SiO_2 + 4H_2O.$$

In acid solutions, rosalic acid imparts a pale-yellow color, and in alkaline solutions, a cherry-red color; end point very sharp. Phenolphthalein solution is also a most satisfactory indicator for this titration. For the determination of the H_2SiF_6, only 0.5 c.c. of the strong solution is needed; this amount was measured by taking 10.0 c.c. of the solution, diluting to 200.0 c.c. and titrating 10.0 c.c., or an equivalent of 0.5 c.c. of the original solution. The solution contained 37.2 grams H_2SiF_6 per 100.0 c.c. It was kept in an ordinary glass bottle until needed for preparing the electrolytes.

Lead fluo-silicate electrolyte was made to contain about 10 grams of lead, as $PbSiF_6$, per 100 c.c. and a half molecular equivalent of free fluo-silicic acid (3.4 grams H_2SiF_6 per 100 c.c. solution), by adding a weighed amount of white lead ($2PbCO_3 \cdot Pb(OH)_2$) to a measured volume of the fluo-silicic acid solution. Before using

the lead fluo-silicate solution, it was filtered, and its lead and fluo-silicic acid content determined as follows: The lead was precipitated from 10 c.c. of the solution as lead sulphate, dried, ignited and weighed; the total H_2SiF_6 (free, and combined with lead) was determined by taking 10.0 c.c. of the solution, diluting to 100.0 c.c. and titrating 10.0 c.c. of this solution (equivalent to 1.0 c.c. original solution), at 75° to 85° C. with standard potassium hydrate solution, using rosalic acid indicator. The end point is represented by the two equations

$$H_2SiF_6 + 6KOH = 6KF + SiO_2 + 4H_2O,$$

$$PbSiF_6 + 6KOH = 6KF + SiO_2 + Pb(OH)_2 + 2H_2O,$$

6KOH is equivalent to one SiF_6.

The copper fluo-silicate electrolyte was prepared to contain about 6 grams of copper as $CuSiF_6$ per 100 c.c. and a quarter molecular equivalent of free acid (5.5 grams H_2SiF_6 per 100 c.c. solution) by dissolving a weighed amount of ignited pure cupric oxide in a measured volume of the fluo-silicic acid solution, in the proportion represented by the equation

$$H_2SiF_6 + CuO = CuSiF_6 + H_2O.$$

Five fourths this quantity of acid was taken, giving the desired excess. The composition of the resulting solution was determined, after filtering it, by titrating the copper content in 2.5 c.c. with standard potassium cyanide solution; and the fluo-silicic acid content titrated as follows: 10.0 c.c. of the solution was diluted to 500.0 c.c.; 50.0 c.c. was taken for analysis and diluted with an equal volume of ethyl alcohol, and an excess of an alcoholic solution of potassium acetate added, which precipitated all the fluo-silicic acid according to

$$CuSiF_6 + 2K \cdot C_2H_3O_2 = Cu(C_2H_3O_2)_2 + K_2SiF_6,$$

$$H_2SiF_6 + 2K \cdot C_2H_3O_2 = 2H \cdot C_2H_3O_2 + K_2SiF_6.$$

The precipitate of K_2SiF_6 was washed three times by decantation and twice on a filter with 50 per cent. alcohol. The filter paper and the precipitate were then placed in a beaker containing 100 c.c. water, was heated to boiling and titrated hot with standard potassium hydrate solution, using rosalic acid indicator. End point represented by the equation

$$K_2SiF_6 + 4KOH = 6KF + SiO_2 + 2H_2O,$$

4KOH is equivalent to one SiF_6.

Silver fluo-silicate electrolyte was made to contain about 4 grams silver (as Ag_2SiF_6) and 0.67 gram free fluo-silicic acid per 100 c.c. (one quarter molecular equivalent of free acid). It was prepared in the following manner: 40.0 grams of pure metallic silver was dissolved in a slight excess of nitric acid, the solution evaporated to dryness, and the mass treated with about 200 c.c. distilled water. To the solution was added a slight excess of a strong solution of sodium carbonate, which precipitated the silver as carbonate. The precipitate was washed by decantation, until free of sodium salts, and then a measured volume of the fluo-silicic acid added to the same beaker containing the precipitate. Reaction:

$$H_2SiF_6 + Ag_2CO_3 = Ag_2SiF_6 + H_2O + CO_2.$$

Five-fourths this quantity of acid was used, giving the desired amount of free acid present. By diluting to one liter the solution contained 4 per cent. silver and 0.67 per cent. free acid.

The Electrolysis.

The electrolyses were conducted in No. 2 and No. 3 beakers, the electrodes being strips cut from sheets of the pure metal, the size, in the case of the copper and the lead cells, was 2.5 by 3.3 inches. A mark was scratched on the cathodes at such a height (2.5 inches from bottom) as to give the desired current density, when the current was on. The distance between the anode and the cathode, in each cell, was 1 inch, and was maintained as such by wooden spanners, which were wooden strips with two parallel notches sawed 1 inch apart, and into which the electrodes were secured. The current was supplied by a battery of storage cells, and properly regulated by means of rheostats.

I. *Lead Electrolytes, which contained no "Addition-Agent."*

The first set of experiments was conducted with lead nitrate and lead fluo-silicate electrolytes; the lead nitrate electrolytes contained 10 grams lead and 1.46 grams free nitric acid per 100 c.c. (one quarter molecular equivalent of free acid), and the lead fluo-silicate electrolyte contained 10 grams lead and 3.4 grams free fluo-silicic acid per 100 c.c. (one half molecular equivalent of free acid). The temperature of the electrolytes during the time of the electrolysis was maintained constant by having the cells in water-baths. The data obtained by these runs is given in Table I., experiments 1 to 12, inclusive.

TABLE I. ELECTROLYSIS OF LEAD ELECTROLYTES, WHICH CONTAINED NO "ADDITION-AGENT."

Exp. No.	Electrolyte.	Grams per 100 c c. Lead.	Grams per 100 c c. Free Acid.	Amperes.	C.D. Amperes per Sq. Ft.	Average E.M.F. per Cell.	Temp. of Electrolyte. Degrees C.	Time of Run. Mins.	Anode Loss in Grams.	Cathode Gain in Grams.	Character of the Deposit.	Plate. Plate.	Plate. No.	Remarks.
1	$Pb(NO_3)_2$	10	1.46	0.42	10	0.22	20	90	3.207	2.643	Very poor.	I.	1	Deposit of fine, loosely coherent crystals, easily detached.
2	"	10	1.46	0.42	10	0.22	40	90	3.828	1.998	Poor.	I.	2	Deposit similar to No. 1, but crystals not so long.
3	"	10	1.46	0.42	10	0.18	60	90	4.908	1.987	Very poor.	I.	3	Deposit of loosely adherent, dendritic crystals.
4	$PbSiF_6$	10	3.4	0.42	10	0.18	20	90	2.933	2.881	Moderately good.	I.	7	Deposits generally smooth and coherent, with few needle crystals on edge of the plate. The deposits on the surface of the cathodes were dense and adhered well to the cathodes.
5	"	10	3.4	0.42	10	0.16	40	90	2.934	2.827	" "	I.	8	
6	"	10	3.4	0.42	10	0.13	60	90	2.963	2.877	" "			
7	$Pb(NO_3)_2$	10	1.46	1.26	30	1.35	20	41	3.803	2.929	Very poor.	I.	4	Surface of cathode covered with long dendritic crystals very loosely attached. A number of the crystals dropped to the bottom of the cell.
8	"	10	1.46	1.26	30	0.84	40	41	5.536	2.290	" "	I.	5	
9	"	10	1.46	1.26	30	0.64	60	41	5.417	Not weighed	" "			Deposit so loosely attached to cathode, that most all fell off during the electrolyses. Deposited as dendritic crystals.
10	$PbSiF_6$	10	3.4	1.26	30	0.63	20	41	3.978	3.443	Poor.	I.	10	Cathode covered with very fine plate-like crystals, some spear-shaped, and loosely attached.
11	"	10	3.4	1.26	30	0.46	40	41	3.988	3.444	"	I.	11	In general appearance these deposits similar to No. 10, but the crystals not so long, the shortest crystals in case of No. 12.
12	"	10	3.4	1.26	30	0.39	60	41	4.068	3.385	"	I.	12	

In experiments 1 to 6, when 0.42 ampere was passed for 90 minutes, the theoretical amount of lead, which should have been deposited, is 2.4306 grams, taking the electro-chemical equivalent of lead as 0.0010717 gram per coulomb. In experiments 7 to 12, when 1.26 amperes was passed for 41 minutes, the theoretical amount of lead deposited is 3.3218 grams. The amount of lead dissolved from the anodes and deposited on the cathodes should be the same in each cell. With the nitrate electrolytes, the difference in the weights, of the anode loss, and the cathode gain, are very large. This is explained by the fact that the free acid in the electrolyte chemically dissolved lead from the anodes; and also from the cathodes, and the higher the temperature of the electrolytes the greater is the loss of the anodes, and the less the gain of the cathodes. With the fluo-silicate electrolytes, the chemical action of the free acid on the electrodes is less apparent, even though there was present twice the molecular equivalent of free acid than was in the nitrate electrolytes. The discrepancy in the gain in weight of the anodes and the loss in weight of the cathodes in the fluo-silicate electrolytes is accounted for by the loss of some of the crystals from the cathode during the process of washing, drying, and weighing.

As to the effect of current density upon the character of the deposits, it was found, that with higher current density, the deposit formed less coherent and was composed of longer and more easily detached crystals. With rise of temperature, the effect of higher current density was partially counteracted, that is, the deposits which formed at 60° C. were composed of shorter crystals, which were more coherent, and which adhered more strongly to the cathode than the deposits which formed at 20° or at 40° C. The character of the deposits are illustrated by Plate I., Figs. 1 to 12.

II. *Copper Electrolytes, which contained no "Addition-Agent."*

This series of experiments was conducted with cupric sulphate, cupric fluo-silicate, and cuprous chloride electrolytes; the composition of each was:

(*a*) The cupric sulphate electrolyte contained 16 grams cupric sulphate ($CuSO_4.5H_2O$), and 4 grams free sulphuric acid per 100 c.c. solution, or 4.1 grams copper, and two thirds molecular equivalent of free acid.

(*b*) The cupric fluo-silicate electrolyte contained 6.34 grams

PLATE I.

Lead

Tempt.

$Pb(NO_3)_2$ $PbSiF_6$

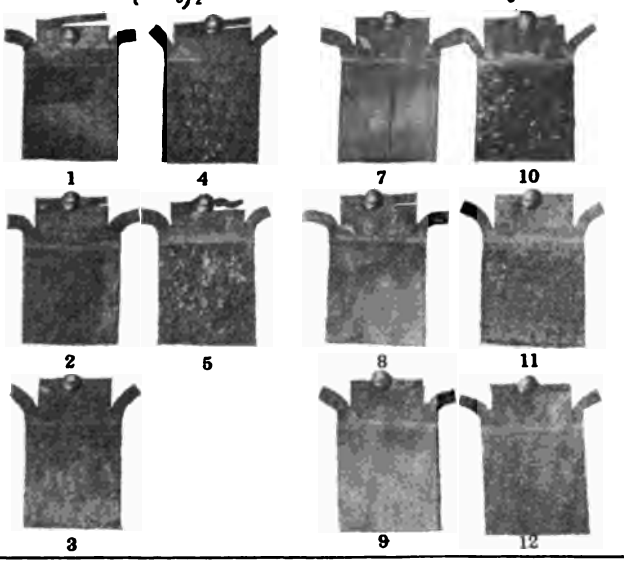


PLATE III.

Electrolyte

Tempt. 20°C

REAGENT	$Pb(NO_3)_2$	$PbSiF_6$	$PbSiF_6$
Tannin	40	44	48
Resorcine	41	45	49
Pyrogallol	42	46	50
Gelatine	43	47	51
Current D=APSq ft.	30	30	30

TABLE II. ELECTROLYSIS OF COPPER ELECTROLYTES, WHICH CONTAINED NO "ADDITION-AGENTS."

Exp. No.	Electrolyte.	Grams per 100 c.c. Copper.	Grams per 100 c.c. Free Acid.	Average Amperes.	C.D. Amperes per Sq. Ft.	Average E.M.F. per Cell.	Temp. of Electrolyte. Degrees C.	Time of Run. Mins	Anode Loss in Grams.	Cathode Gain in Grams.	Character of the Deposit.	Photo Plate.	Photo No.	Remarks.
13	$CuSo_4$	4.1	4.0	0.39 0.10	10.0 2.3	0.29 0.25	20	234 76	2.015	1.964	Good.	II.	1	Surface of cathode smooth and bright. Deposit solid.
14	"	4.1	4.0	0.39 0.10	10.0 2.3	0.20 0.17	40	234 76	2.034	1.941	"	II.	2	Deposit similar to No. 13.
15	"	4.1	4.0	0.39 0.10	10.0 2.3	0.16 0.14	60	234 76	2.064	1.886	"	II.	3	Deposit similar to No. 13.
16	$CuSiF_6$	6.34	3.6	0.39 0.10	10.0 2.3	0.22 0.18	20	234 76	2.105	1.983	"	II.	4	Deposits dense, smooth and very adherent. More bright than those formed in the copper sulphate electrolytes.
17	"	6.34	3.6	0.39 0.10	10.0 2.3	0.15 0.13	40	234 76	2.031	1.959	"	II.	5	
18	"	6.34	3.6	0.39 0.10	10.0 2.3	0.10 0.08	60	234 76	2.055	1.707	"	II.	6	
19	$CuSO_4$	4.1	4.0	1.96 0.04	50.0 1.0	1.19	20	380 80	15.942	15.736	Not very good.	II.	7	Surface of cathode thickly covered with dense crystals, which adhered well to the plate.
20	"	4.1	4.0	1.96 0.04	50.0 1.0	0.88	40	380 80	15.920	15.724	Fairly good.	II.	8	Deposit smoother than No. 19, the surface of plate smoother.
21	"	4.1	4.0	1.96 0.04	50.0 1.0	0.79	60	380 80	15.947	15.662	Not very good.	II.	9	Deposit similar to No. 19, but not so good as No. 20.
22	$CuSiF_6$	6.34	3.6	1.96 0.04	50.0 1.0	0.84	20	380 80	15.825	15.734	Good.	II.	10	Much smoother and brighter deposit than No. 20. Surface of plate crystalline.
23	"	6.34	3.6	1.96 0.04	50.0 1.1	0.58	40	380 80	15.923	15.708	"	II.	11	Not so crystalline as No. 22.
24	"	6.34	3.6	1.96 0.04	50.0 1.0	0.49	60	380 80	15.968	15.698	Very good.	II.	12	Best deposit of series; smooth and free from adherent crystals. Hard and bright.

TABLE II. ELECTROLYSIS OF COPPER ELECTROLYTES, WHICH CONTAINED NO "ADDITION-AGENTS."—*Continued.*

Exp. No.	Electrolyte.	Grams per 100 c.c.		Average Amperes.	C.D. Amperes per Sq. Ft.	Average E.M.F. per Cell.	Temp. of Electrolyte. Degrees C.	Time of Run. Mins.	Anode Loss in Grams.	Cathode Gain in Grams.	Character of the Deposit.	Photo.		Remarks.
		Copper.	Free Acid.									Plate.	No	
25	$CuSiF_6$	6.34	3.6	0.40 0.15	10.0 3.8	20	0.25	157 68	1.471	1.431	Good.	II.	13	Surface of cathode smooth and free from crystalline growths. This cell was run as a check on cells Nos. 26, 27 and 28.
26	Cu_2Cl_2 NaCl	1.7	0.0	0.40 0.15	10.0 3.8	0.45	20	157 68	2.513	2.270	Very poor.	II.	14	Deposit very crystalline and loosely adherent to the cathode. Spanglar plate-crystals.
27	"	1.7	0.0	0.40 0.15	10.0 3.8	0.20	40	157 68	3.154	2.526	"	II.	15	Similar in all re pects to No. 26.
28	"	1.7	0.0	0.40 0.15	10.0 3.8	0.14	60	157 68	3.169	2.575	"	II.	16	
29	$CuSiF_6$	6.34	3.6	1.47	38	0.62	24	45			Very good.			Smooth, bright, dense deposit, free from adherent crystals. Run as check on cells Nos. 30, 31 and 32.
30	Cu_2Cl_2 NaCl	1.7	0.0	1.47	38	0.68	50	45			Very poor.			Deposits consisted of loosely attached plate-crystals, which could not be washed nor dried without dropping from the cathodes.
31	"	1.7	0.0	1.47	38	0.88	40	45			"			
32	"	1.7	0.0	1.47	38	0.38	60	45			"			

copper, and 3.6 grams free hydro-fluo-silicic acid per 100 c.c. solution (an excess of acid in proportion to one quarter molecular equivalent).

(*c*) The cuprous chloride electrolyte was prepared to contain 1.7 grams copper as cuprous chloride, and 15 grams sodium chloride per 100 c.c. solution, which is a saturated solution of cuprous chloride in a 15 per cent. solution of sodium chloride. No free acid present.

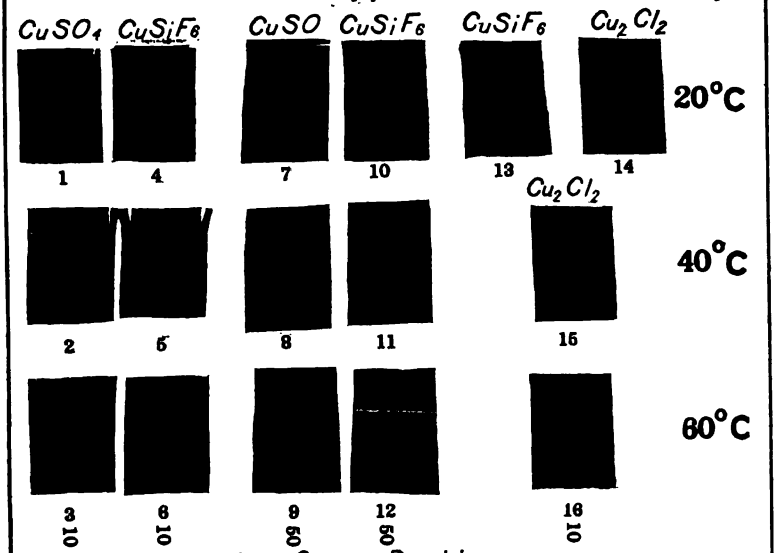
The electrolysis was performed with sets of three cells connected in series, but at three different temperatures, one cell was at 20° C., one at 40° C., and the third at 60° C., in order that the effect of temperature upon the deposition could be determined.

The current density used in one series of runs was maintained at 10 amperes per square foot, and another series at 50 amperes per square foot. The surface of the electrodes exposed to action was, in all cases, 2.5 by 2.5 inches, or 6.25 square inches. The distance between the electrodes was 1 inch.

The data obtained are recorded in Table II.

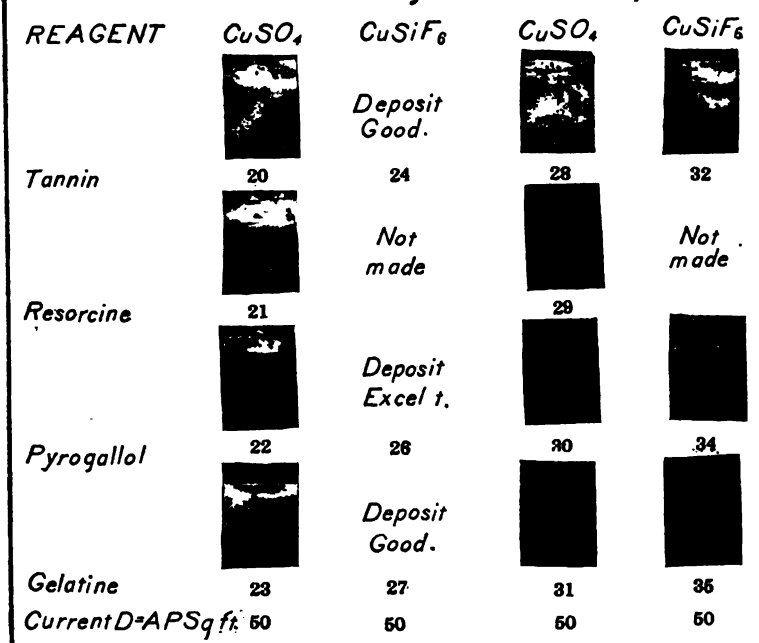
The deposits formed in the sulphate and the fluo-silicate electrolytes, when the electrolyses were conducted at a current density of 10 amperes per square foot, were smooth, bright, solid, and coherent, in each case, whether the temperature of the electrolyte was at 20°, 40°, or 60° C. The deposits formed in the fluo-silicate electrolytes were more bright, and less crystalline than those formed in the sulphate electrolytes. The data of these runs are recorded in Table II., experiments no. 13 to no. 18. The total time of the electrolysis was 310 minutes (5 hours and 10 minutes), 234 minutes at 0.39 ampere, and 76 minutes at 0.10 ampere. The reason for running each of the cells at the two different current densities, was the necessity of leaving the electrolysis unwatched for about an hour. The theoretical amount of copper deposited during these runs, the electro-chemical equivalent of copper being 0.3294 mg., was 1.952 grams. Comparing the weights of the copper actually deposited, the cathode-gain in each case, when the electrolytes were at a temperature of 20° and 40° C., approximated the theoretical amount; but when the temperature was 60° C., the cathode-gain was considerably less than theory. The anode-loss in each case was more than the cathode-gain, which is accounted for by a small amount of impurity, which the anodes contained, and which dropped to the bottom of the cell, as a "sludge." The

PLATE II. Copper Tempt.



Amps. per square foot = Current Densities.

PLATE IV. Electrolyte Tempt. 20°C



discrepancy in the weights of the deposits formed in the electrolytes at 60° C. is due to chemical corrosion of the cathodes, along the line of contact of the electrolyte and the atmosphere, which corrosion did not occur with the electrolytes at lower temperatures.

In order to better compare the character of the deposits formed in sulphate and in fluo-silicate electrolytes, and also to determine the effect of the temperature upon the deposition, a series of cells were electrolyzed at a current density of 50 amperes per square foot of electrode-surface. The data are recorded in Table II., experiments no. 19 to no. 24. The total time of the electrolysis was 460 minutes (7 hours and 40 minutes), 380 minutes with a current of 1.96 amperes, and 80 minutes with a current of 0.04 ampere. The theoretical amount of copper deposited was 14.782 grams, based on the electrochemical equivalent of copper as 0.3294 mg. The average cathode-gain was 15.71 grams; the agreement in the cathode-gain of this set of experiments is close, especially when the electrolytes were at 20° and 40° C. The deposit formed in the sulphate electrolyte at 60° C. weighs less, due to chemical corrosion. The lower calculated weight of the copper deposited is accounted for by the error in reading the ammeter, and the length of time of the run, which magnified the error.

The results of these sets of experiments may be summarized as follows: The deposits formed in copper sulphate electrolytes at 40° C. are smoother and brighter than those formed at a temperature of 20° or 60° C.; however, in the case of the fluo-silicate electrolytes, the smoother and the brighter deposits formed at 60° C.; and also, the deposits formed in the fluo-silicate electrolytes are much brighter and less crystalline than those formed in sulphate electrolytes, the conditions of electrolysis being the same.

The deposits which formed in the cuprous chloride electrolytes were, in each case, very unsatisfactory, being precipitated as loosely-adherent, spanglar, plate-crystals, which, unless the electrolytes were most vigorously stirred, would have bridged the electrodes and short-circuited them. Variation of the temperature of the electrolytes, and of the current density, caused no apparent improvement on the deposition. The data are recorded in Table II., experiments no. 26 to no. 28 and no. 30 to no. 32.

III. *Lead Electrolytes, which contained "Addition-Agent."*

This series of experiments was conducted with lead electrolytes, to which were added a small amount of an "addition-agent."

The size of the electrodes, their distance apart, and the volume of the electrolytes were the same as operated with, when no "addition-agent" was present (Series I.).

As it was found that free acid in the lead nitrate electrolytes (Series I., experiments no. 1 to no. 3 and no. 7 to no. 9) caused chemical corrosion of the electrodes, the free acid in the nitrate electrolytes of this series was reduced to 0.75 gram per 100 c.c. solution (one eighth molecular equivalent of free acid).

The lead fluo-silicate electrolytes were of similar percentage composition to those used in Series I.

The current density used was 30 amperes per square foot, and the temperature of the electrolytes 20° C., these conditions having been selected because of the fact that deposits of lead formed with higher current density and at lower temperatures are more crystalline, and less coherent; therefore, by electrolyzing under these conditions, the effect of the presence of an "addition-agent" could be more readily distinguished.

The "addition-agents" tried were tannin, resorcinol, pyrogallol, and gelatine, each of which was dissolved in a quantity of warm distilled water, diluted to a measured volume and added to the respective electrolytes in measured amounts. The volume of the solution added at the start was such that the electrolyte contained one part by weight of the "addition-agent" in 5,000 parts of electrolyte. When it was found that the character of the deposition was not altered, a further addition was made. In the cases of the lead nitrate electrolytes, it was found that these "addition-agents" restrained the crystallization to a certain extent, when they were present in the proportion of about one part by weight to 250 parts of electrolyte; but even when present in this large proportion, the deposition was unsatisfactory, especially with each of the "addition-agents" except tannin. With tannin, the deposit was much better than those formed in the electrolytes which contained one of the other "addition-agents." The presence of the tannin, in the lead nitrate electrolyte, caused the precipitation of the metal as a more coherent, less sharply crystalline mass; instead of the crystals forming with sharp edges, they verged into the nodular condition. The data obtained are recorded in Table III., experiments no. 33 to no. 36.

With the lead fluo-silicate electrolytes, we have an electrolyte which has proven most satisfactory in the technical refining of lead

TABLE III. ELECTROLYSIS OF LEAD ELECTROLYTES, WHICH CONTAINED "ADDITION-AGENTS."

Exp. No.	Electrolyte.	Grams per 100 c.c.		Average Amperes.	C.D. Amperes per Sq. Ft.	Average E.M.F. per Cell.	Temp. of Electrolyte. Degrees C.	Time of Run. Mins.	"Addition Agent" Present	Ratio: Wt. of Agent to Wt. of Electrolyte.	Character of Deposit.	Photo.		Remarks.
		Lead.	Free Acid.									Plate.	No.	
33	$Pb(NO_3)_2$	10	0.75	1.3	30	0.47	20	185	Tannin.	1 : 5000 to 1 : 714	Poor.	III.	40	Cathode covered with long dendritic crystals, 1 to 10 mm. length, loosely adhered. Better than deposits of Nos. 34, 35, and 36. Edges of the crystals were rounded.
34	"	10	0.75	1.3	30	0.43	20	185	Resorcinol.	1 : 5000 to 1 : 220	Very poor.	III.	41	Deposit similar to Exp. 33, but less long dendritic crystals, and less adherent. The edges of crystals more sharp than those found in Exp. No. 33.
35	"	10	0.75	1.3	30	0.44	20	185	Pyrogallol.	1 : 5000 to 1 : 333	" "	III.	42	Deposit similar to No. 34. Dendritic crystals, 2 to 18 mm. length, covered the cathode.
36	"	10	0.75	1.3	30	0.43	20	185	Gelatine.	1 : 5000 to 1 : 220	" "	III.	43	Deposit similar to Exps. No. 34 and 35.
37	$PbSiF_6$	10	3.4	1.3	30	0.64	20	114	Tannin.	1 : 5000	Good.	III.	44	Hard, dense, smooth deposit, with no crystals, nor nodules.
38	"	10	3.4	1.3	30	0.56	20	114	Resorcinol.	1 : 1000	Poor.	III.	45	Cathode covered with a dense growth of dendritic crystals, with rounded edges. The crystals easily separated from the cathode.
39	"	10	3.4	1.3	30	0.58	20	114	Pyrogallol.	1 : 5000	Fairly good.	III.	46	The deposit for the most part was dense, and coherent, with the exception of several groups of dendrites near the edge of cathode.

TABLE III. ELECTROLYSIS OF LEAD ELECTROLYTES, WHICH CONTAINED "ADDITION-AGENTS."—*Continued.*

Exp. No.	Electrolyte.	Grams per 100 c.c.		Average Amperes.	C.D. Amperes per Sq. Ft.	Average E.M.F. per Cell.	Temp. of Electrolyte. Degrees C.	Time of Run. Mins.	"Addition-Agent" Present.	Ratio: Wt. of Agent to Wt. of Electrolyte.	Character of Deposit.	Photo.		Remarks.
		Lead.	Free Acid.									Plate.	No.	
40	$PbSiF_6$	10	3.4	1.3	30	0.58	20	144	Gelatine.	1 : 5000	Very good.	III.	47	Dense, adherent, smooth deposit, several small nodules formed along edge of cathode.
41	"	10	3.4	1.3	30	0.59	20	185	Tannin.	1 : 5000	Good.	III.	48	Dense deposit, with some small adhering nodules, but free of crystallization.
42	"	10	3.4	1.3	30	0.59	20	185	Resorcinol.	1 : 1250	Poor.	III.	49	Surface of cathode covered with long dendritic crystals, 1 to 6 mm. length, and which are loosely attached.
43	"	10	3.4	1.3	30	0.58	20	185	Pyrogallol.	1 : 5000	Fairly good.	III.	50	Deposit dense and coherent; along edge of plate some small dendritic nodules, which were very adherent.
44	"	10	3.4	1.3	30	0.58	20	185	Gelatine.	1 : 5000	Very good.	III.	51	Dense coherent smooth deposit, with few nodules on edge of the cathode.

alloys, and of base bullion. Its successful application being due principally to the fact that the presence of a small quantity of certain "addition-agents" causes the lead to be deposited as a dense, non-crystalline, coherent, metallic mass. It was found, by this series of experiments, that when either tannin, pyrogallol, or gelatine are present in lead fluo-silicate electrolytes in the proportion of one part by weight in 5,000 parts of the electrolyte, the lead deposited as a bright, solid, coherent mass, whereas, when one of these "addition-agents" is absent, the deposit forms as a mass of non-coherent, dendritic crystals. The most satisfactory of these three "addition-agents" was found to be gelatine, which caused the lead to deposit smooth, bright, dense, and free from apparent crystallization. Tannin had the same effect as the gelatine, but to a slightly less degree; it caused the lead to deposit smooth, bright and dense-but with an apparent crystalline structure. Pyrogallol was not so effective as the tannin; with the presence of one part in 5,000 parts of electrolyte, the lead deposited as a dense, coherent mass, with adherent dendrites along the edge of the cathode. Possibly by increasing the proportionate amount of the pyrogallol, the deposit would form free of the dendrites. Resorcinol was found to be an unsatisfactory "addition-agent" for lead fluo-silicate electrolytes, even when present in the proportion of one part in about 1,000 parts of electrolyte; it restrained the crystallization of the deposition, but did not cause it to form as a dense, coherent mass. The results of this series are recorded in Table III., experiments no. 37 to no. 44.

IV. *Copper Electrolytes, which contained "Addition-Agent."*

This series of experiments was conducted with copper electrolytes, to which were added one of the "addition-agents."

The composition of the electrolytes was the same as that of the electrolytes which were used in the experiments of Series II. The temperature of the electrolytes in experiments no. 49 to no. 52, and no. 56 to no. 58 was approximately 30° C.; in the other experiments of this series, the temperature was 20° C. The current density in each case was maintained at about 50 amperes per square foot. The data obtained are recorded in Table IV., experiments no. 45 to no. 61.

The "addition-agents" tried with the copper sulphate electrolytes were tannin, resorcinol, pyragallol, and gelatine; those tried

with the copper fluo-silicate electrolytes were tannin, pyrogallol, and gelatine; and those with the cuprous chloride electrolytes were pyrogallol, gelatine, and dextrine.

Standard solutions of the "addition-agents" were prepared by dissolving a weighed amount of each in warm water and diluting the solution to a measured volume. A certain measured volume of each of these standard solutions was added to the respective electrolytes, and the effect of its presence noted. The first amount added was of such a volume as to give an electrolyte containing one part of reagent per 5,000 parts of solution. If no apparent effect was noted at once, a further addition of the standard solution was made, and this repeated until an alteration in appearance of the deposition was apparent. The minimum and the maximum proportions tried are recorded in Table IV.

With the copper sulphate electrolyte it was found that the presence of either tannin, resorcinol or gelatine caused the copper to deposit more smoothly. The deposits were rendered more smooth by maintaining the temperature at 30° C. than at 20° C. Pyrogallol did not improve the deposition, but caused it to form darker.

The deposits from the copper fluo-silicate electrolytes were rendered more smooth and brighter by the presence of a small amount of either tannin, pyrogallol or gelatine. Tannin was the most effective "addition-agent," and pyrogallol and gelatine somewhat less effective, but similar to each other. By electrolyzing at 30° C., instead of at 20° C., the deposits formed smoother and brighter.

The presence of either pyrogallol, gelatine or dextrine in the cuprous chloride electrolytes did not restrain the crystallization of the deposited copper. These experiments were repeated several times, but as they gave no promise of success in producing solid, coherent deposits, the cuprous chloride electrolyte was not further tried.

V. *Silver Electrolytes, which contained no "Addition-Agent."*

The electrolyses of the silver electrolytes were conducted with solutions of silver nitrate, and siver fluo-silicate, which contained 4 grams of silver per 100 c.c. solution.

The silver nitrate solution was prepared by dissolving a weighed amount of pure, electrolytic silver in nitric acid, evaporating to dryness, taking up with distilled water, adding a few drops of nitric

TABLE IV. ELECTROLYSIS OF COPPER ELECTROLYTES, WHICH CONTAINED "ADDITION-AGENTS."

Exp. No.	Electrolyte.	Grams per 100 c.c.		Average Amperes.	C.D. Amperes per Sq. Ft	Average E.M.F. per Cell.	Temp. of Electrolyte. Degrees C.	Time of Run. Mins.	"Addition-Agent" Present.	Ratio: Wt. of Agent to Wt. of Electrolyte.	Character of the Deposit.	Photo.		Remarks.
		Copper.	Free Acid.									Plate.	No.	
45	$CuSO_4$	4.1	4.0	2.13	50	1.64	20	220	Tannin.	1 : 5000	Rough deposit.	IV.	20	Solid, coherent, rough deposit. Surface of cathode covered with small nodules. Vigorous agitation of electrolyte necessary to prevent $CuSO_4 . 5H_2O$ forming on the anode.
46	"	4.1	4.0	2.13	50	1.66	20	220	Resorcinol.	1 : 5000	Less rough than 45.	IV.	21	
47	"	4.1	4.0	2.13	50	1.63	20	220	Pyrogallol.	1 : 5000	Rough, dark deposit.	IV.	22	Deposit similar to that of Exp. 45 in character, but of darker color.
48	"	4.1	4.0	2.13	50	1.63	20	220	Gelatine.	1 : 5000 to 1 : 714	Fairly smooth.	IV.	23	Dense, coherent, fairly smooth deposit. The increased addition of gelatine caused the deposition to form smoother. Few nodules along edge of the plate.
49	"	4.1	4.0	2.20	52	1.42	32	334	Tannin.	1 : 5000 to 1 : 1250	Very good.	IV.	28	Dense, coherent, and smooth deposit; few nodules along edge of cathode. Weight of deposit 14.06 grams.
50	"	4.1	4.0	2.20	52	1.43	32	334	Resorcinol.	1 : 5000 to 1 : 1250	Fairly good.	IV.	29	Dense, coherent deposit; not so smooth as cathode 28 (Exp. 49). Weight of deposit = 14.29 grams.
51	"	4.1	4.0	2.20	52	1.41	31	334	Pyrogallol.	1 : 5000 to 1 : 866	Poor.	IV.	30	Rough, dark deposit; surface of cathode covered with mass of nodules. Weight of deposit = 14.37 grams.
52	"	4.1	4.0	2.20	52	1.56	31	334	Gelatine.	1 : 2500 to 1 : 833	Very good.	IV.	31	Smooth, dense deposit; few nodules along the edge. Weight of deposit = 14.45 grams.

TABLE IV. ELECTROLYSIS OF COPPER ELECTROLYTES, WHICH CONTAINED "ADDITION-AGENTS." — *Continued.*

Exp. No.	Electrolyte.	Grams per 100 c.c.		Average Amperes.	C.D. Amperes per Sq. Ft.	Average E.M.F. per Cell.	Temp. of Electrolyte. Degrees C.	Time of Run. Mins.	"Addition-Agent" Present.	Ratio: Wt. of Agent to Wt. of Electrolyte.	Character of the Deposit.	Photo.		Remarks.
		Copper.	Free Acid.									Plate.	No.	
53	$CuSiF_6$	6.34	5.5	2.13	50	1.10	20	220	Tannin.	1 : 5000	Good.			Fairly smooth and dense deposit, scattered groups of nodules along and near edge of the cathode.
54	"	6.34	5.5	2.13	50	1.05	20	220	Pyrogallol.	1 : 5000 to 1 : 2500	Very good.			Deposit dense and smooth, free from nodules.
55	"	6.34	5.5	2.13	50	1.15	20	220	Gelatine.	1 : 5000	Good.			Similar to deposit found in Exp. 53.
56	"	6.34	5.5	2.20	52	0.96	30	334	Tannin.	1 : 5000	Excellent.	IV.	32	Smooth, dense, coherent, bright deposit; free from nodules. Weight of deposit = 14.35 grams.
57	"	6.34	5.5	2.20	52	0.95	30	334	Pyrogallol.	1 : 5000 to 1 : 1000	Very good.	IV.	34	Similar to deposit in Exp. 56, but with few nodules along edge. Weight of deposit = 14.35 grams.
58	"	6.34	5.5	2.20	52	1.02	29	334	Gelatine.	1 : 5000	Very good.	IV.	36	Similar to deposit in Exp. 57. Weight of deposit = 14.36 grams.
59	Cu_2Cl_2 NaCl	2	0.0	1.45	40		20		Pyrogallol.	1 : 5000 to 1 : 500	Very poor.			The presence of the reagent in the electrolyte had no apparent effect on retarding the deposition of non-coherent crystalline mass. Deposits were similar to those formed when no reagent was present.
60	"	2	0.0	1.45	40		20		Gelatine.	"	" "			
61	"	2	0.0	1.45	40		20		Dextrine.	"	" "			

acid, and finally diluting to such a volume that it contained 4 grams of silver per 100 c.c.

The silver fluo-silicate electrolyte contained 4 grams silver and 0.67 gram free fluo-silicic acid per 100 c.c. solution (or a quarter molecular equivalent of free acid). It was prepared as outlined under the heading "*Preparation of Electrolytes.*"

TABLE V. ELECTROLYSIS OF SILVER ELECTROLYTES, WHICH CONTAINED NO "ADDITION-AGENT."

Exp. No.	Electrolyte.	Grams per 100 c.c.		Average Ampere.	C.D. Amperes per Sq. Ft.	Average E.M.F. per Cell.	Temp. of Electrolyte. Degrees C.	Time of Run. Minutes.	Character of the Deposit.	Remarks.
		Silver.	Free Acid.							
62	$AgNO_3$	4	trace	0.47	15	0.88	20	175	Crystalline	Cathode covered with a fairly coherent mass of fine crystals. Along edge of the cathode long needles from 2 to 15 mm. in length.
63	"	4	"	0.47	15	0.62	40	175	"	Similar to deposit of Exp. 62. Crystals along edge not so long, up to about 10 mm. in length.
64	"		"	0.47	15	0.51	60	175	"	Similar to deposits of Exps. 62 and 63. Length of crystals along edge of cathode from 10 to 15 mm.
65	Ag_2SiF_6	4	0.67	0.47	15	0.71	20	175	Crystalline	Rather firmly adherent deposit formed on the start, but became rougher as the time of deposition increased. Silica separated during the electrolysis, and remained suspended in the solution.
66	"	4	0.67	0.47	15	0.50	40	175	Fair	Much denser deposit than that of Exp. 65. Surface of cathode appeared finely crystalline; no growth of nodules over the deposit, except along edge of the plate. Some silica separated.
67	"	4	0.67	0.47	15	0.41	60	175	Crystalline	Deposit more crystalline than that of Exp. 65. Edge of cathode covered with dense growth of longer crystals, with rounded edges. Some silica separated.

The anodes were sheets of rolled silver, about one sixteenth inch thick, and the cathodes were thin, polished sheets of silver. The surface of the electrodes exposed to electrolytic action was 2 by 2.25 inches, or 4.5 square inches. The distance between the anode and the cathode of each cell was 1 inch; they were held in place

by a wooden spanner, similar to those used for the lead, and for the copper electrodes.

In order to determine the effect of temperature upon the character of the deposit, the experiments were conducted with a set of three cells connected in series; the temperature of one cell was maintained at 20° C., one at 40° C., and one at 60° C., by having the cells in separate water-baths.

The current density used was 15 amperes per square foot. The data obtained are given in Table V., experiments no. 62 to no. 67.

The deposits formed at 40° C. in the nitrate, and in the fluo-silicate, electrolytes were more coherent, and the crystals, of which the deposits were composed, were of less length than those formed in the electrolytes at 20° C. and at 60° C. The deposits formed in the electrolytes at 60° C. were not so coherent as those formed in the electroiytes at 20° C. or at 40° C.

The deposits formed in the fluo-silicate electrolytes were more coherent than those formed in the nitrate electrolytes, when the temperature and the current density in each case were the same.

During the electrolysis of the fluo-silicate electrolytes, a small amount of flocculent silica separated, and for the most part remained suspended in the solution. It did not interfere with the electrolysis.

Plates, illustrating the deposits of silver, are not given, as the deposited silver was without color, being perfectly white, and the photographs which were taken do not show the structure, nor the comparative differences of the deposits.

VI. *Silver Electrolytes, which contained "Addition-Agents."*

The effect of the presence of "addition-agent" was determined by electrolyzing solutions of similar composition as those used for Series V., experiments no. 62 to no. 67.

The "addition agents" tried were tannin, resorcinol, pyrogallol, and gelatine. Standard solutions of these were made in the same manner as previously described, and a measured volume added to the respective electrolytes in the proportionate amount as recorded in Table VI.

The current density employed was 16 amperes per square foot, and the temperature of the electrolytes was 20° C.

The only favorable results obtained by this series of runs were those of experiment no. 71 and no. 75, with the electrolytes which

TABLE VI. ELECTROLYSIS OF SILVER ELECTROLYTES, WHICH CONTAINED "ADDITION-AGENTS."

Exp. No.	Electrolyte.	Grams per 100 c.c.		Average Ampere.	C.D. Amperes per Sq Ft.	Average E.M.F. per Cell.	Temp. of Electrolyte. Degrees C.	Time of Run. Mins.	"Addition-Agent" Present.	Ratio: Wt. of Agent to Wt. of Electrolyte.	Character of the Deposit.	Remarks.
		Silver.	Free Acid.									
68	$AgNO_3$	4	Trace.	0.49	16	0.87	20	87	Tannin.	1 : 11,000	Poor.	Very brittle deposit, which peeled from cathode. Dark color.
69	"	4	"	0.49	16	0.85	20	87	Resorcinol.	1 : 1,700	Poor.	Reagent did not alter character of deposit as formed when electrolyte contained none. Similar to deposit formed in Exp. 62.
70	"	4	"	0.49	16	0.86	20	5	Pyrogallol.	1 : 10,000	Precipitate.	Dark precipitate of cement silver formed on adding the pyrogallol.
71	"	4	"	0.49	16	0.95	20	87	Gelatine.	1 : 14,000	Fair.	Solution became dark on standing. The gelatine caused the formation of a finer crystalline deposit, and more adherent. Long crystals along edge of plate retarded by its presence.
72	Ag_2SiF_6	4	0.67	0.49	16	0.76	20	87	Tannin.	1 : 11,300	Poor.	Dark colored, brittle deposit, which peeled from the cathode. The crystals which were deposited were smaller than when no agent present.
73	"	4	0.67	0.49	16	0.84	20	87	Resorcinol.	1 : 1,700	Poor.	Deposit similar to that of Exp. 72, but not so dark colored.
74	"	4	0.67	0.49	16	0.85	20	5	Pyrogallol.	1 : 10,000	Precipitate.	The pyrogallol precipitated cement silver, on addition.
75	"	4	0.67	0.49	16	0.86	20	87	Gelatine.	1 : 14,000	Fair.	Solution became dark on standing. Very brittle solid deposit; the crystallization almost wholly retarded, only few nodules along the edge of the plate.

contained gelatine in the proportion of one part by weight to 14,000 parts of electrolyte. The presence of the gelatine restrained the crystallization of the deposition, causing the crystals to form smaller, and to adhere to the cathode. A further increase of gelatine was made to the electrolytes, gradually increasing the proportionate amount present to one part in 3,500 parts of electrolyte, but no improvement in the deposition was noted; in fact, with the greater amount present, the deposition was less satisfactory.

On adding pyrogallol to the silver solutions, a dark slimy precipitate was produced, and the cathode deposit formed as black, non-adherent precipitate.

Resorcinol and tannin had no beneficial effect upon the deposits of silver formed in the silver nitrate electrolytes, but the effect of their presence in the silver fluo-silicate electrolytes was apparent. With the tannin in the latter electrolyte, in the proportion of one part by weight to 11,300 parts of electrolyte, the deposit was darkened, and the crystals composing the deposit were smaller and more coherent than when no tannin was present. The presence of resorcinol in the silver fluo-silicate electrolyte, in the proportion of one part by weight to 1,700 parts of electrolyte, slightly improved the coherency of the deposit.

The effect of the presence of any one of the four "addition-agents," in larger amounts than the proportions recorded in Table VI., was found to be detrimental instead of beneficial. The amounts in each case were increased to one part in about 2,500 parts of electrolyte, and without an exception, no improvement on the deposition of the silver resulted. The effect of the larger amount of "addition-agent" was a less adherent deposit, a darker colored electrolyte, and the precipitation of colloidal silver.

The electrolytes to which any one of the four "addition-agents" was added, even in the smallest amount, became dark colored on standing.

Summary of Experimental Part.

The deposits of lead, copper, and silver tend to form more crystalline and less coherent with higher current densities. The smoother deposits form with lower current densities.

With rise in temperature, of the electrolytes of lead, copper, and silver, up to 60° C., the tendency of the depositions is to form more coherent, denser, and less crystalline.

The fluo-silicate electrolytes of lead, copper, and silver give more coherent deposits than those formed in the nitrate electrolytes of lead or silver, or in the sulphate or chloride electrolytes of copper.

The crystallization of the deposits of lead, formed in an almost neutral electrolyte of lead nitrate, is restrained by having present one part of either tannin, resorcinol, pyragallol or gelatine per 250 parts of electrolyte. The deposits, however, in all cases were composed of a mass of non-coherent crystals. Tannin is the most satisfactory "addition-agent" for lead nitrate electrolyte.

Gelatine, tannin, and pyrogallol, when present in lead fluo-silicate electrolyte in the proportion of one part by weight to 5,000 parts electrolyte causes the lead to deposit as a smooth, dense, coherent mass. The most effective of these "addition-agents" is gelatine, the next is tannin, and the least effective is pyrogallol. Resorcinol is not a suitable "addition-agent" for this electrolyte.

The deposits of copper, from copper sulphate electrolytes, are rendered smoother and brighter by the presence in the electrolyte of either tannin, resorcinol or gelatine; tannin is the most effective, resorcinol is less, and gelatine is the least effective of the three. Pyrogallol is not a suitable "addition-agent" for this electrolyte, as it causes the deposited copper to form dark colored.

The deposits of copper from copper fluo-silicate electrolyte were rendered smoother and brighter by the presence in the electrolyte of either tannin, pyrogallol or gelatine. Tannin is the most effective of the three.

The deposits of copper from cuprous chloride electrolytes are not improved by the presence in the electrolyte of either gelatine, pyrogallol or dextrine. Elevation in temperature of this electrolyte does not cause the copper to deposit more coherent.

Silver is deposited as finer crystals and in a more coherent form from electrolytes of silver nitrate and silver fluo-silicate, when the electrolytes are at a temperature of 40° C., than when at a temperature of either 20° or 60° C.

Deposits of silver from silver fluo-silicate electrolyte are more coherent than deposits formed in silver nitrate electrolyte.

Gelatine, when present in silver nitrate, and in silver fluo-silicate, electrolytes, in the proportion of one part per 10,000 to 14,000 parts electrolyte, causes the deposit to form as shorter and smaller crystals, which are more coherent than when gelatine is not present.

Pyrogallol, tannin and resorcinol are not suitable "addition-agents" for silver nitrate, or fluo-silicate electrolytes.

TABLE VIII. EFFECT OF "ADDITION-AGENT" IN THE ELECTROLYTE UPON THE DEPOSIT.

Electrolyte.	Gelatine.	Tannin.	Pyrogallol.	Resorcinol.
$PbSiF_6$	Densest deposit.	Denser deposit.	Dense deposit.	Deposit not improved.
$CuSiF_6$	More smooth and bright deposit.	Most smooth and bright deposit.	Smooth, dense deposit.	Deposit not improved.
Ag_2SiF_6	Coherent deposit.	Deposit not improved.	Deposit not improved.	Deposit not improved.
$Pb(NO_3)_2$	Less crystaline and more coherent deposit.	Deposit much improved.	Deposit not improved.	Deposit not improved.
$AgNO_3$	More coherent deposit.	Deposit not improved.	Deposit not improved.	Deposit not improved.
$CuSO_4$	Brighter and smoother deposit.	Brighter and smoother deposit.	Dark deposit.	Deposit not improved.
$Cu_2Cl_2..xNaCl$	Deposit not improved.	Deposit not improved.	Deposit not improved.	Deposit not improved.

CONCLUSIONS.

The effect, which the presence of "addition-agents" has upon the deposits of lead and silver from their fluo-silicate and their nitrate electrolytes, and upon the deposits of copper from its fluo-silicate and its sulphate electrolytes, cannot be attributed to any specific physical property of the "addition-agent."

The only property, in common, of the "addition-agents," which were found to be beneficial in improving the deposits of lead, copper, and silver, is the larger number, and the similar arrangement of the hydroxyl radicals. The hydroxyl radicals of pyrogallol and of tannin are in the position 1, 2, 3, in the benzene ring. Resorcinol ($C_6H_4(OH)_2$) differs from pyrogallol ($C_6H_3(OH)_3$) in that it contains two hydroxyls in the position 1, 3. Therefore, to the extra hydroxyl of pyrogallol, in the position 2, may be attributed the cause of rendering denser, smoother and brighter deposits from lead fluo-silicate and copper fluo-silicate electrolytes.

Tannin ($C_{13}H_3(OH)_3(COOH)_2$) differs from pyrogallol in that it contains two benzene groups; still these compounds are similar in that their hydroxyls are in adjoining positions. Tannin was found to be a more satisfactory "addition-agent" than pyrogallol, so it may be said that the two extra hydroxyl radicals in the tannin is what causes more satisfactory deposits from not only lead fluo-silicate

and copper fluo-silicate electrolytes, but also the deposits from electrolytes of copper sulphate, and lead nitrate.

The chemical structure of gelatine cannot be compared with that of either tannin or pyrogallol, as its composition is not fully known. The only thing in common, is that gelatine is composed of groups of benzene rings, which contain hydroxyl and amino-radicals. Whether it is the larger number of hydroxyl and, as well, the amino-radicals of the gelatine, which is the cause of the formation of the most satisfactory deposits of lead, copper and silver from their respective electrolytes, when gelatine is the "addition-agent," remains to be proven.

With these generalities in mind, it may be said: that, the most suitable "addition-agents" for lead, copper, and silver electrolytes are compounds of the benzene ring series, which have a large number of adjoining hydroxyl radicals; and also, the greater the molecular weight of the "addition-agent" (or in other words, the larger the number of hydroxyls), the more effective it is in producing more satisfactory deposits.

If it is the hydroxyl (and, as well, the amine) radicals of "addition-agents" which causes the deposits to form denser, smoother, and less crystalline, then no doubt this effect may be attributed to the reducing property of the "addition-agents." This statement was suggested by recalling a general rule of organic chemistry, which is: the most easily oxidizable organic compounds of the benzene ring series, and those which more readily precipitate metals from their solutions, are compounds which contain the largest number of hydroxyl, or amine radicals; and the compounds which are most easily oxidized are those in which the hydroxyl, and the amine, radicals are the more closely grouped.

In the selection of an "addition-agent" there is no known specific property, nor characteristic chemical composition, which may be used as a guide in the selection. The "addition-agent" which is the most suitable one for a certain electrolyte may not prove beneficial when added to another electrolyte which contains either a similar anion or a similar cathion.

At the present time, with the lack of reliable data, the only means of selecting the most suitable "addition-agent" is patient experimenting. However, this general statement may be made: that the greater the molecular weight of the "addition-agent," and the larger the number of adjoiningly grouped hydroxyl (and

amine) radical which the compound contains, the more effective it is in producing denser, brighter, less crystalline and more coherent deposits of lead, copper and silver.

Whether the hydroxyl radical of the "addition-agent" effects the ionization of the constituents of the electrolyte, and thereby alters the character of the deposited metal, is a problem for the physical chemist to solve.

MODERN PRACTISE IN COLOR PHOTOGRAPHY.*

By ALFRED NORTON GOLDSMITH.

The attempt to reproduce the natural colors of objects in a picture of them by means of photography may be regarded, according to one's individual point of view, either as an admission of weakness — of lack of artistic power in oneself — or as a praiseworthy desire to invoke the powers of nature to do what, with all human skill, no artist can ever expect to do or ever claims to do. It is possible for the artist to represent any scene to the senses of man by the aid of painting or drawing. That he will not always succeed in accomplishing his task is but to be expected.

We cannot consider fully and justly the position of the color photographer as a student of art. But we have no doubt that but few artists will have their appreciation of color values and color harmony further developed, or their ambition to reproduce nature more excited than the careful and earnest manipulator of the camera and sensitive plate. The disappointments of the color photographer are frequent; and his patience and persistence are often sorely tried. But to him these discouragements are not true obstacles but rather incentives to renewed effort. Each failure has its value, and the artist knows this also only too well.

We may now pass to the consideration of the means of achieving successful results in this field — to the practical methods of producing color photographs. That method which is in our common possession and practise employs colored glasses or colored filter elements to feed the photographic plate, leaving the latter to record an impression depending on its own particular sensitiveness.

It is necessary to distinguish sharply between the two theoretical methods of color photography, the additive process and the subtractive process. We shall first consider the additive method, that based on the addition of colored lights.

Suppose that a solar spectrum be thrown on a screen out of which are cut three narrow strips corresponding in position to the

* Based on a Lecture delivered before the Sigma Xi Society of Columbia University in October, 1908.

wave-lengths 6,700, 5,100, and 4,600; that is, wave-lengths in the red, green, and blue-violet parts of the spectrum. There will then pass through the screen three approximately monochromatic bands of light. By appropriate optical means these three bands of color can be again combined into a single strip of color. Such means are mirrors, prisms or lenses so arranged as to finally superpose the three bands of color. The intensity or brilliancy of each band may be varied by placing before the corresponding slit gray glasses or an adjustable rotating sector. It will then be found that by suitable varying the intensities of the three bands, that the strip of color which is their sum can be made to duplicate to our eyes all the colors of nature. This is an experimental fact for which no explanation will be here attempted. The principle then is established that every color in nature can be reproduced to the eye by the combination in the proper proportions of the three primary colors, red, green and violet.

To carry out this principle, the light coming from an object must first (by means explained below) be analyzed into its component portions of red, green and violet. By recording the proportion of each of these primary colors a color record of the object is obtained from which by proper means the original colors can be reproduced. It should be here noted that what is obtained is a color record, but not color; exactly as a phonograph record is not sound but a sound record, from which by proper means the original sound may be reproduced.

Three pictures of the same object are taken on three different plates without moving the camera. The first is taken through a violet glass, the second through a green glass, and the third through a red glass. These three pictures will record the violet, green and red parts of the light from the object respectively. These negatives are in black and white. The colored glasses through which they are taken are significantly termed color filters. The negatives thus obtained will be called the violet filter, green filter and red filter negative respectively. From them are made three positives, which will be called the violet filter, green filter and red filter positive respectively. The violet filter positive is to be illuminated with violet light, and its image thrown on the screen or otherwise viewed. The green filter positive is to be illuminated by green light, and its image superposed on that of the first. And, lastly, the red filter positive is to be illuminated by red light and its im-

age superposed on those of the other two. Then the object will stand out on the screen in the colors of nature for the light coming from the object has first been analyzed and then synthesized. A simple example will make this clearer.

Suppose that a red object is thus photographed. The light from it would act on the red filter negative, but not on the other two, because the green and violet filters cut off red light. So that the red filter negative would be black, while the other two negatives would show clear glass. In consequence the red filter positive would be clear glass and the other two positives black. When these positives are properly illuminated in the way described above only red light would be seen, and thus the original color is reproduced. By a method entirely similar to that just given the conclusion can easily be reached that the original color will be finally reproduced for objects of a violet color, a green color, or of the most complex color which can be produced by a mixture of the three primary colors. An objection to this method is that paper prints cannot be produced. The picture is entirely made up of colored lights and while quite visible cannot be fixed on paper. In the subtractive method of color photography this objection no longer holds.

This latter is, in fact, the only method at present known which is practicable enough to enable it to be widely used for such commercial purposes as color printing. The beautifully colored halftones which are seen nowadays in our magazines are many of them three-color photographs by the subtractive method, the printing press being merely an adjunct.

In principle this method is identical with the first. The three negatives are obtained as before, but instead of printing from them three black and white positives, three colored positives are printed. The positives in this process are prints in transparent pigments such as can be placed on paper. A change in the manipulation must here be made. The red filter positive is not printed from the red filter negative in a red pigment but in a pigment of the complementary color, namely, greenish-blue. The reason for this is simple. Suppose that a greenish-blue object be photographed. The red filter negative will not be acted on, and will therefore be clear glass. The other two negatives will be black (owing, of course, to the reduction of the acted-on silver bromide in the emulsion to silver during development). So that only the red

filter negative will print, in the sense that light can pass through it to the sensitized printing surface. It must therefore be printed in greenish-blue, and not in red. Remembering this point it will be easily seen that every object may be reproduced in its natural colors if the colors of the pigments be correctly chosen. This correct choice is by no means a simple matter, in fact, no set of permanent pigments of exactly the right hues is known. The photographer is compelled to use either the brilliant aniline dyes of somewhat doubtful permanency or else the commercial lake printing inks, which because of their failure to comply with theoretical requirements frequently lead to degraded or muddy colors. Nor is it easy to print each of the positives to the correct intensity and accurately superpose them. In the present state of our knowledge of such complicated phenomena as the different density curves (that is, varying gradation) of the same plate to different colored lights, it is difficult to specify exactly what shall be the absorption of each of the color filters used in making the negatives. This difficulty, however, is rather theoretical than actual since sensitometric methods devised by Sir William Abney and Josef Maria Eder make it possible to ascertain experimentally whether the absorption is correctly chosen, and if it be incorrect, how to improve it. In spite of these difficulties, the process is used extensively commercially, and the results are in general extremely satisfactory.

The general objections to the three-color process are the necessity for three plates, each or all of which shall be sensitive to special colors, the lengthened exposures behind color filters, the expense of three negatives and three positives, and the difficult and prolonged manipulation.

The practical manipulations of color photography will be next considered, beginning with the additive process. One of the first to apply this method in practice was Frederick E. Ives, of New York City. He devised the "chromoscope" whereby through an ingenious arrangement of color reflectors and filters the images of the three positives are accurately superposed. The method is one admitting of considerable fidelity of reproduction but unfortunately the public is not yet educated to the point of willingness to employ a somewhat bulky apparatus to view a color photograph not on paper.

Naturally the first object of the inventor has been the avoidance

of three separate negatives taken through the red, green and violet color filters. Instead of employing these filters a glass plate ruled with fine lines of transparent colored inks is placed in front of the plate and in contact with it. These ruled lines are alternately red, green and violet and they function as filters. If we print a positive transparency from a negative thus obtained it is found that on placing the colored line screen over it in correct position the colors of the object are reproduced. This process was first employed by Dr. Joly, of Dublin University, and Mr. Macdonough, of Chicago. At present it is used by Mr. Powrie, of Chicago. The latter by a very ingenious device has succeeded in making the ruled lines so fine that there are six hundred to the inch. He has thus succeeded in at least partially eliminating one of the chief defects of the process, namely, the obtrusiveness of the ruled structure of the pictures. Another application of the same principle is the celebrated Lumière Autochrome process of which so much has been heard recently.

In this process instead of lines of color dots of color are used. These dots of color are dyed starch grains. They are nearly transparent, very small, and after sifting quite uniform in size. Their average diameter is about 0.00052 inch or 0.013 millimeter. One third of them are stained violet, one third green, and one third red. When the three heaps are mixed together the color disappears and a gray heap results. When they are spread out and stuck on glass it looks somewhat like ordinary ground glass, dimming to a gray the white light which passes through it. The starch grains are crushed down until they form a continuous succession of elementary color filters and the spaces between them filled with fine charcoal. The plate is then coated with an ordinary silver bromide emulsion, made as nearly panchromatic as possible, that is, equally sensitive to all colors.

The plate so prepared is exposed in a camera with the glass side towards the lens. The light must then pass through the layer of colored starch grains before it reaches the sensitive silver bromide and a color record of it is thus obtained. The latent image is then developed as usual, care being taken however that no light of any color, even red, falls on the plate before development is complete. The silver of the developed image is dissolved out by means of a solution of sulfuric acid and potassium permanganate, which solution does not attack the undeveloped silver bromide in the emul-

sion. After rinsing, this silver bromide is reduced to metallic silver by a second development. Thus the erstwhile negative has been converted into a positive. Suppose that the object photographed was a violet. The light from it can pass only through the violet grains, for the red and green are opaque to it. By the peculiar process of development and reversal the spot covered by the violet grain is cleared of its silver. Therefore on holding the plate up to the light the spot under consideration will look violet.

The result then is a positive and can be used only as a transparency or lantern slide. Owing to the fact that the color layer must absorb part of the light and that a yellow screen must be used to reduce in effect the excessive sensitiveness of the plate to violet light, the time of exposure is rather long, being about fifty times that required for ordinary plates. The entire process of development takes only about half an hour. The natural colors are satisfactorily reproduced, and the grain is so fine as to be hardly noticeable.

Other plates of this general type are on the market or will shortly be on the market. Among these may be mentioned the Du Hauron and Bergecol Omnicolore Plate, the Powrie-Warner Florence Heliochromatic Plate, and the Thames Color Plate. In all of these a colored line screen is used, and they differ among themselves only in the spacing and arrangement of the lines and in a few details of manipulation.

The practical features of the subtractive process will next be treated. The plates which we employ in this process are also panchromatic and must be handled and developed in entire darkness as even a faint red light would fog them. Such plates are Cramer's Trichromatic, Wratten and Wainwright's Allochrome, Lumiere's Series C plates, Sanger Shepherd's Series B plates, and Otto Perutz's Perchromo plates. The colors of the filters through which the pictures are to be taken should be very carefully adjusted and the relative exposures behind each accurately determined. These exposures will not be the same because of the different sensitiveness of the plate for various colors. To facilitate the taking in rapid succession of the three pictures a special so-called repeating back may be fitted to the camera. This is a sliding frame which holds the filters in the correct positions before the plates. Such cameras are made by Horn, Bermpohl, Sanger Shepherd, and in a modified form by Frachebourg. Or a camera

may be used which by a suitable arrangement of reflectors permits the photographer to take all three pictures simultaneously, as that of Sanger Shepherd. The negatives are developed by time, the principle involved being that all correctly exposed negatives are fully developed in a known developer in a constant time. An exposure meter, such as those of Wynne or Watkins, may be employed to ensure correct exposure. We make color prints from our three negatives, and place the three prints in accurate superposition. To obtain the greenish-blue, red and yellow prints the familiar carbon process or the somewhat less familiar gum bichromate process may be used. Each of these furnishes a picture in colored gelatine or gum. Each is based on the power of light to render gelatine or gum impregnated with potassium or ammonium bichromate insoluble in hot water, by hardening it. In the carbon process an actual relief in colored gelatine is obtained on a suitable temporary support and then transferred to the paper which is to carry the complete three-color print. Extremely artistic effects can be gotten by the carbon and gum processes.

The dye factory of Meister, Lucius and Bruning, of Hoechst, Germany, have put on the market their so-called Pinatype process, the invention of Leon Didier. A glass plate coated with bichromated gelatine is printed, for example, from the red filter positive. Behind the clear portions of the positive the gelatine is hardened, and in these hardened portions it will not absorb any of the special greenish-blue dye furnished by the factory. After soaking it in the dye solution it can be employed as a printing plate by pressing it smoothly into contact with a gelatine coated paper. Then some of the dye will diffuse into the gelatine film of the paper. By repeating the process with the other two printing plates there will be obtained a complete picture in colors on the gelatine coated paper. Sanger Shepherd's Imbibition Process is similar to the last mentioned, the sole difference lying in the use of a dye-soaked gelatine *relief* supported on celluloid as a printing plate. In this relief the softened gelatine has been washed away before dyeing. The printing plate is made in this process by printing from the filter negatives and not from the filter positives as in the Pinatype process. It is probable that the last two mentioned processes are the easiest, most reliable, and inexpensive processes at the disposal of the color photographer at present, if he desire paper prints. With a little care he may obtain prints with a surprisingly

faithful rendition of color, and this without any extraordinary technical skill.

We must also consider the recent and highly interesting bleach-out processes of Szczepanik and of Dr. Smith, of Zurich. Dr. Smith coats his "Uto" paper with an emulsion containing three somewhat fugitive dyes and also the bleaching agents or sensitizers, hydrogen peroxide and anethol. If a sheet of this paper is exposed to sunlight through a colored transparency, the dyes will bleach to the colors of the positive. This depends on the principle that a fugitive dye can be bleached only by light of the color which it absorbs, so that blue light, being absorbed by all but the blue dye which reflects it, will bleach out the yellow and red dyes leaving the blue dye unchanged. Fixation is at least partially accomplished by the removal of the sensitizers.

At present there are but few photographers who make color photographs commercially which is not astonishing considering what the requirements of a really successful process must be. It must be so simple and inexpensive as to compare favorably with ordinary monochromatic photography. Toward this ideal only the first few steps have as yet been taken.

No department of photography is so bound to honesty as color photography. The photographer cannot do much more than influence considerable areas at a time, alter the lighting and color scheme of the original, and vary his own point of view or plane of sharpest definition. The attempt to change the color of details in the finished picture is hardly likely to be accomplished with great success though in time even the necessary skill for this may be developed.

Color photography will undoubtedly reveal the fallacies and empty pretensions of poor painting while stamping with the approval of nature the methods of the truly great artist. It will be of immense value to the scientist, and particularly to members of the medical profession who can thus preserve permanent and correct records of unusual cases. Absolutely authentic copies of paintings and family portraits can be made of a veracity of which no doubt can be entertained, and with but small expenditure of time. Museums will have on file accurate color photographs of the collections of similar institutions thus greatly widening the scope of their own usefulness. Indeed, when one considers the manifold purposes to which photography is now applied and how

its value would by increased by the addition of color, one begins to appreciate the importance of this field. And color photography will provide those who, though endowed with a keen appreciation of the beauties of nature, are hampered by the lack of the technique of the painter with a means of expression which cannot but prove an invaluable acquisition to them.

THE SEPARATION AND IDENTIFICATION OF THE MOST IMPORTANT CONSTITUENTS OF ESSENTIAL OILS.

By ALFRED HOFFMAN.

Although the examination of special oils for some one or two most valuable constituents in each case is amply treated in the books on commercial organic analysis, the following scheme for separating and identifying the parts of any essential oil may be of interest. Much of the material here given is contained in a less concise form in Semmler's "Die aetherischen Oele."

In the preliminary examination of the oil, attention is directed mainly to its physical properties. It may be a clear liquid or, as in the case of rose oil, it may contain a solid deposit. The latter is increased by cooling the oil in a freezing mixture and then filtered off and examined separately. If colored, the oil may be any shade of yellow or brown, or even green or blue. For purposes of identification, the solubility of the oil in various mixtures of alcohol and water may be taken. Fatty oils and petroleum fractions, if present as adulterations, will show by their insolubility. The former are identified by the odor of acrolein on heating with potassium bisulphate, the latter by their indifference toward concentrated sulphuric and nitric acids. A distillation, if necessary under diminished pressure, will show by the size of the fractions whether the oil is a complicated one. The classes of substances usually present will boil as follows: Below 150°, methyl and ethyl alcohols, acetone, acetaldehyde, etc.; 150°–190°, terpenes with ten carbon atoms and alcohols and ketones with less; 190°–230°, alcohols, aldehydes and ketones with ten carbon atoms; 250°–300°, sesquiterpenes with fifteen carbon atoms and their derivatives.

If the oil is a complicated one, a systematic separation is carried out as follows: The oil is dissolved in a liberal amount of ether and shaken with aqueous reagents in the order given.

1. Dilute sodium carbonate solution is used to remove acids. The latter may be recovered by acidifying the soda solution with dilute sulphuric acid and extracting with ether.

2. Phenols are separated by repeated extraction with very dilute

sodium hydroxide solution, dilute so as not to affect the aldehydes which may be present, and regenerated as above.

3. Basic nitrogen compounds, if present, are removed with dilute sulphuric acid. This refers principally to the methyl ester of anthranilic acid.

4. Test for sulphur and, if present, shake with mercuric chloride solution to remove mercaptans, thio-ethers, disulphides and mustard oils.

5. Extract the aldehydes and methyl ketones by shaking with sodium bisulphite solution. The latter is then boiled with the addition of sodium carbonate and the aldehydes and ketones extracted with ether. If ketones are present which do not react with bisulphite, they are transformed into the semicarbazones, after distilling off the ether, by adding to the oil a saturated solution of semicarbazid chlorhydrate and sodium acetate in water, and enough alcohol to make the mixture homogeneous. On standing the semicarbazone crystallizes out. It is filtered off and distilled with steam in the presence of phthalic anhydride to regenerate the ketone. The ketones and aldehydes may be separated by fractional distillation or, if this is not possible, by oxidizing the aldehydes to acids with silver oxide.

6. Esters are saponified by boiling with alcoholic caustic potash, after removing the ether. The potash solution is poured into water and extracted with ether. The aqueous solution contains the potash salts of the acids. The Zeisel methyl determination for esters and ethers and the esterification and saponification figures for alcohols will not be discussed here as they are contained in the treatises on commercial analysis.

7. Alcohols can usually be separated from the hydrocarbons and ethers by fractional distillation. The boiling point may be raised, if necessary, by esterifying by boiling the oil with acetic anhydride. Primary alcohols frequently combine with solid calcium chloride to crystalline compounds, which may be decomposed with water after filtering off and washing with ether. Another method, which works well with primary and to a certain extent also with secondary alcohols, is the phthalester separation. The oil is boiled in benzol solution with phthalic anhydride, the mixture poured into dilute aqueous alkali and extracted with ether. The alcohols dissolve in water as the alkaline salts of the half-ester of phthalic acid and may be regenerated by distilling with steam after addition of sodium carbonate.

8. The hydrocarbons and ethers are purified by distillation over metallic sodium.

The various classes of compounds separated as above are subjected to vacuum distillation, when it is possible to readily isolate the constituents even in the most complicated oils.

The identification of the individual substances is accomplished by physical and chemical means. Most important among the physical properties, beside the boiling point, are the specific gravity, the index of refraction and the optical rotation. The first is determined by means of a piknometer, the second most conveniently with a Pulfrich refractometer and the last in the usual manner with a polariscope. Of the chemical tests, those for the hydrocarbons and ethers are still to be discussed. The addition of halogens and halogen acids is done in gasoline, ether or glacial acetic acid solution. The nitrosites are prepared by dissolving the hydrocarbon in gasoline, adding a concentrated solution of sodium nitrite and then the calculated amount of glacial acetic acid drop by drop, cooling well. The derivative crystallizes after several days standing in a freezing mixture. For the nitroso-chlorides, dissolve the oil in glacial acetic acid together with ethyl or amyl nitrite and pour into water after standing.

The following table contains the members of the various classes arranged according to their boiling points at atmospheric pressure: d denotes specific quantity, n_D = index of refraction, a_D = optical rotation, b = boiling point, m = melting point.

Hydrocarbons and Ethers.

— 150°. Various lower paraffins.

155°–156°. *Pinene.* — In turpentine and other pine oils, d_{20}=0.858; n_D = 1.465; a_D varies. Hydrochloride, m 131°. Dibromide, m 169°–170°. The nitroso-chloride on heating with benzylamine in alcohol and pouring into water gives a derivative, m 122°–123°.

160°–161°. *Camphene.* — In various turpentines, citronella oil, etc. m 48°–49°; d_{48} = 0.850; a_D varies. Hydrochloride, m 155° is changed to isoborneol, m 212° by heating with ½ part 50 per cent. sulphuric and 2½ parts acetic acids for 2–3 hours at 50°–60°.

170°–173°. *Phellandrene.* — In eucalyptus oils, etc., d_{20} = 0.842, n_D = 1.475; a_D variable. Several nitrites, m 115°, 105° and 102°, 98°. Rely chiefly on physical constants.

Myrcene. — In bay-oil, $d_{15} = 0.8023$; $n_D = 1.4673$. Optically inactive. Polymerizes readily.

175°–177°. *Limonene and Dipentene.* — In oil of lemon and orange, etc., $d_{20} = 0.846$; $n_D = 1.470$; $a_D = \pm 81°$–$123°$, usually 105°. Limonene tetrabromide, *m* 104°; optically active. Dipentene tetrabromide, *m* 125°–5°, optically inactive and much more insoluble.

Sylvestrene. — In pine-needle oils only, $d_{20} = 0.847$; $n_D = 1.477$; $a_D =$ about $+ 21°$. Dihydrochloride, *m* 72°; optically active.

Cymol. — In many oils in small quantities, $d_{20} = 0.8551$. Terpenes removed by dilute potassium permanganate solution in the cold. Identified by its oxidation products.

Cineol. — Principal constituent of eucalyptus, cajeput and wormseed oils, $d_{20} = 0.926$, $n_D = 1.458$. Dissolve in gasoline, cool, pass in hydrobromic acid gas and filter by suction to obtain the hydrobromide, *m* 56–57°. Can be regenerated with dilute aqueous alkali.

231°–233°. *Safrol.*—In sassafras oil, $m + 8°$; $d_{18} = 1.095$; $n_D = 1.536$. Not soluble in alkali. Identified by odor and physical properties.

Anethol. — In oil of aniseed, *m* 21.6°; $d = 0.989$; $n_D = 1.5624$. Dibromide, *m* 67°.

About 250°. *Sesquiterpenes.*

Alcohols.

198°–200°. *Linalool.* — In rose and linaloë oils, $d_{15} = 0.877$ $n_D = 1.464$. Phenylurethane, *m* 65°.

205°. *Benzyl-alcohol.*—Free and as acetate in tuberose and jasmine oils, $d_{15} = 1.043$; $n_D = 1.538$. Phenylurethane, *m* 70°; phthalester acid, *m* 176°.

212°. *Menthol.* — In peppermint oil, *m* 42°; $d_{44} = 0.8814$.

Borneol. — Free and as acetate in pine-needle oils, etc., *m* 204°; $a_D = \pm 37°$. Acetate, *m* 29°.

219°–221°. *Terpineol.* — In many oils, *m* 38°–40°; $d_{15} = 0.938$; $a_D = + 95°$; $n_D = 1.483$.

224°. *Citronellol.* In rose and geranium oils, $d_{20} = 0.878$; $n_D = 1.470$. Phthalester acid silver salt, *m* 125°–6°.

232°. *Geraniol.* In palmarosa oil, $d_{15} = 0.8851$; $n_D = 1.4766$. Phthalester acid, *m* 47°; silver salt; *m* 133°.

300°. *Sesquiterpene alcohols.*

Phenols.

232°. *Thymol.* — In oil of thyme, $d_0 = 0.994$; *m* 51.5°; phenylurethane, *m* 107°.

236°. *Carvacrol.* — In oil of thyme, $d_{15} = 0.981$; *m* + 1°; $n_D = 1.523$; phenylurethane, *m* 140°.

253°. *Eugenol.* — In oil of cloves, $d_{15} = 1.069$; $n_D = 1.544$; acetyl ester, *m* 31°.

Decomposes. *Vanillin.* — In vanilla beans, *m* 81°. Separate as bisulphite. Oxime, *m* 121°.

Aldehydes.

179°. *Benzaldehyde.* — In bitter almond oil, $d_{15} = 1.049$; semicarbazone, *m* 214°.

204°–209°. *Citronellal.* — In citronella oil, $d_{15} = 0.8681$; $n_D = 1.4601$; semicarbazone, *m* 84°.

228°–229°. *Citral.* — In lemongrass oil, $d_{15} = 0.899$; $n_D = 1.493$; semicarbazones, *m* 164° and 171°.

247°. *Cinnamic aldehyde.* — In cinnamon and cassia oils, $d_{24} = 1.049$; semicarbazone, *m* 208°.

Ketones.

204°. *Camphor.* — In camphor oil, *m* 175°; $d_{10} = 0.992$; $[\alpha]_D = \pm 44.22°$; oxime, *m* 119.5°; semicarbazone, *m* 236°–8°.

208°. *Menthon.* — In peppermint oil, $d_{15} = 0.894$; $n_D = 1.4496$; $\alpha_D = \pm 25°$; oxime, *m* 59°–61°; semicarbazone, *m* 184°.

222°–223°. *Pulegon.* — In pennyroyal oil, $d_{25} = 0.9293$; $[\alpha]_D = +25°$; $n_D = 1.4816$; oxime, *m* 118–19°; semicarbazone *m* 172°.

225°–230°. *Carvon.* — In oil of caraway seed, $d_{15} = 0.953$; $n_D = 1.4995$; $[\alpha]_D = \pm 62°$; gives a compound with hydrogen sulphide, *m* 224°.

Acids.

m 121°. *Benzoic acid.* — As ester in many oils.

m 144°. *Anthranilic acid.* — As ester in neroli oil. Hydrochloride, *m* 191°.

m 155°. *Salicylic acid.* — As ester in oils of wintergreen, sweet birch, etc.

m 67°. *Coumarine* (a lactone). — In various oils.

METALLURGICAL ABSTRACTS.

By WILLIAM CAMPBELL.

Copper.

Cost of Producing the World's Supply of Copper: J. R. Finlay. *E. and M. J.*, 86, 1908, 165. Costs of operations at Wallaroo and Moonta, the Tennessee Copper Company, the Utah Consolidated, Mount Lyell, Granby Consolidated. Copper mines divided into 3 classes: Disseminated ores, concentration the prime factor. Quartz pyrite ores in fissure veins, ratio of concentration low, proportion smelted high, costs usually high. Ores which must be smelted in bulk.

Official Reports of Costs of Producing Copper: A. R. Townsend. *E. and M. J.*, 86, 1908, 555. A comparison of tabulated statements of costs of mining, smelting, etc., from reports of 22 companies.

Constructing a Crude Smelter for Prospectors: F. C. Nicholas. *Min. World*, 28, 1908, 897. Construction of Spanish-American stack. Example from Honduras. Method of building, etc.

A Machine for Casting Converter Copper: J. H. Klepinger. *E. and M. J.*, 85, 1908, 903. The Boston and Montana Consolidated Copper and Silver Mining Co., at Great Falls, have plant consisting of motor-driven self-dumping Walker casting machinery, bosh with overhead return conveyor and a hydraulically operated pouring apparatus.

Kelley Slag and Matte Casting Machine: F. G. Kelley. *E. and M. J.*, 86, 1908, 610. A rocking-tray slag-caster for rich slag from 8 converter stands (320 tons per 24 hours) and occasionally matte. Capacity 500 tons per 24 hours at Garfield Smelter. Sections, plan and elevation shown.

Machine for Charging Copper Melting Furnaces: E. and M. J., 86, 1908, 867. Machine patented by Prosser and Ladd. Lifting fork and pusher. Drawing of machine.

Production of Copper Matte: C. O. Neikirk. *Min. World*, 28, 1908, 863. Figures from practice with a 48″ circular furnace, Gunnison Co., Colo. Better to ship high grade matte, especially where transportation charges are heavy.

Modern Reverberatory Smelting of Copper Ore: C. Offerhaus. *E. and M. J.*, 85, 1908, 1189, 1234. Gives principles of smelting, reactions. Reverberatory smelting as practiced at Anaconda, plan and elevation of reverberatory. Operations.

Regenerative Reverberatory Copper Furnace: F. A. Leas. *E. and M. J.*, 86, 1908, 898. Description and drawings of furnace at Peyton Chemical Co. plant.

Operation of an Anaconda Copper Converter: C. Offerhaus. *E. and M. J.*, 86, 1908, 747. The converter. Reactions. Lining and drying. Charging and blowing. Several excellent photographs.

Improved Copper Converters: H. Haas. *M. and S. P.*, 96, 1908, 469. Made by Union Iron Works Co. Parting-joint between bottom and top placed much above center, rapid corrosion of this joint by matte prevented. Drawings given.

Construction of 100-ton Copper Smelting Plant: C. C. Christensen. *E. and M. J.*, 86, 1908, 847. Size of furnace and calculation of power plant required. Specifications. Drawings of arrangement and section through furnace room.

Five-ton Electrolytic Copper Refining Plant: C. C. Christensen. *Min. World*, 29, 1908, 523. Calculations on consumption of electricity, etc. Arrangements of anodes, vats, circulation.

A Copper Precipitating Plant. H. W. Chittenden. *E. and M. J.*, 86, 1908, 852. Copper Queen Consolidated, Bisbee. Precipitation by tin cans. Over 90 per cent. extraction.

The Tank House and Copper Furnaces of the New Addition to the Raritan Copper Works: F. D. Easterbrooks. *Electro-Chem. and Met. Ind.*, VI., 1908, 245. Description of tank house and arrangements with plans and sections, anode furnaces, wire bar furnaces, photographs.

Pyritic Smelting at Tilt Cove, Newfoundland: F. S. Nicholls. *E. and M. J.*, 86, 1908, 462. During 1894–97 copper ore (Cu 3.69, S 34.98, Fe 37.06, SiO_2 13.23) was smelted without coke. Matte ran 7 per cent. copper. Cost $1.37 per ton ore.

The Westby-Sorensen Process: E. P. Jennings. *E. and M. J.*, 86, 1908, 418. Experiments at Utah Con. Smelter, Murray. Process consists of (1) treatment of finely divided moistened slag by sulphurous smoke: slag decomposed; (2) precipitation of copper by the thionate in the solution upon the application of heat; (3) recovery of the iron. Comparison of Weill and Westby-Sorensen process.

Alumina in Copper Blast-furnace Slags: C. F. Shelby. *E. and M. J.*, 86, 1908, 270. A number of typical analyses of copper slag given, Hofman's experimental slags, a number of iron blast-furnace slags in tabular form. In copper matting blast-furnace slags alumina is always an active acid.

Mining and Smelting in the Ducktown District: E. Higgins. *E. and M. J.*, 86, 1908, 1237. Ore in great lenses: 2–2.5 per cent. Cu, 18–40 Fe, SiO_2 10–45, CaO 5–8, Al_2O_3 2–4, S 17–30. Tennessee Copper Co. smelter has 7 blast furnaces, three 56 × 180″ and four 56 × 270″, 16 ft. settlers. Four electric converter stands, 15 converters of Leghorn type. Pyritic smelting, first matte 15 per cent. Cu; second matte 32 per cent. Coke used 6.5–7 per cent. First flux is quartz. For second run some limestone is added.

Growth of the Cananea Copper Smelting Works: C. F. Shelby. *E. and M. J.*, 86, 1908, 954. Six excellent photographs showing some of the changes during the last few years.

Some Notes from the Cananea Copper Field: C. A. Dinsmore. *Min. World*, 29, 1908, 393. Equipment of surface plants. Eight 400-ton blast furnaces. Oil fired reverberatory. Concentrating plant.

Mining and Smelting in Shasta Copper Belt: A. H. Martin. *Min. World*, 29, 1908, 309. Mammoth mine. Smelter of five furnaces 50 × 180″. 2 converter stands. Mountain Copper Co. Keswick smelter. Balaklala mines and smelter, three 56 × 240″ furnaces, one 17 × 95 ft. reverberatory. McDougall roasters. Bully Hill mines and smelter, two 42 × 200″ furnaces. Hot blast. 75-ton reverberatory. Great Western Co., one furnace. Matte shipped to Utah.

Erection and Equipment of the Tintic Smelter: L. S. Palmer. *Min. World*, 29, 1908, 473. Situated between Robinson and Silver City. Sample mill. 2 hand reverberatory roasters, 20 tons each. 4 more to be added and a mechanical Kelly sintering furnace. Two 200-ton lead furnaces 48 × 160″. Copper furnace 44 × 120″, 150 tons to be increased to 500.

Mining and Reduction of Ely Ores: R. L. Herrick. *M. and M.*, 29, 1908, 84, 167. Mining. Concentration. Smelting. Sixteen 8 ft. McDougalls, capacity 800 tons. Blast furnace 44 × 960 in., daily capacity 1,200 tons. Reverberatories of McDougall type, three 19 ft. × 112 ft., total capacity of 900 tons per day. Three 400 h.p. Babcock and Wilcox boilers for waste heat. Matte runs 50 per cent. Cu. Three stands for 96 in. × 150 in. Leghorn converters. 85 tons of blister a day.

Development in the Ely District of Nevada: L. A. Palmer. *Min. World*, 28, 1908, 981. Equipment of mill, smelter sixteen 8 ft. McDougalls. Blast furnace and reverberatory. Power house described.

Development of San Pecho Mountain, New Mex.: R. B. Brinsmade. *Min. World*, 28, 1908, 1021. Geology. Gold gravel working. Copper ores. Santa Fe Gold and Copper Co. Proposed mill. Smelter 42 × 120. Settler 7 × 4½ × 3ft. high. 50–60 per cent. matte. Slag SiO_2 42, iron oxide 16.5, CaO 27.5, Al_2O_3 10. Power house.

Mining and Milling near Silver City, New Mex.: R. B. Brinsmade. *Min. World*, 29, 1908, 947. History and development. Equipment of Comanche mill and smelter. Santa Rita copper deposits and plant.

Douglas Smelting Works, Fundicion, Sonora: W. P. Tucker. *E. and M. J.*, 86, 1908, 413. Illustrations of plant. Mining and smelting costs. Total $15.73.

Notes on a Douglas Copper Property in Mexico: W. P. Tucker. *Min. World*, 29, 1908, 595. Compania Metalurgica y Refinadora del Pacifico, S. A., at Fundicion. Costs. Views of plant.

Copper-Gold Smelting at Magistral: R. Linton. *M. and S. P.*, 96, 1908, 843. Luster M. and S. Co. near Santa Maria del Oro, Durango. Gold-silver-copper ore. Three 40 × 168 in. blast furnaces, McDonald stoves. 2 settlers to a furnace. Analyses of ores and charges. Matte 15 per cent. Cu. $186.30 Au per ton. Matte fall 5.4 per cent. Slag 46.9 per cent. SiO_2, 34.4 per cent. FeO, 10 per cent. CaO.MgO, 6.4 per cent. Al_2O_3.

Smelting at Cerro de Pasco, Peru: L. W. Strauss. *M. and S. P.*, 96, 1908, 637. La Fundicion de Tinyahuarco is 14,000 ft. above sea level. Ores 4–15 per cent. Cu, 3–10 oz. Ag, 4–13 per cent. Pb from

Cerro de Pasco. The Morococha ore runs 9–10 per cent. Cu, 10–15 oz. Ag. Sample mill has 3 Vezins and 1 Bridgeman. Coal washer. 2 McDougalls. 4 blast furnaces. Reverberatory 19 × 60 ft. 4 converter stands. Several tables of ore, slag and matte analyses given. Table of costs.

The Mining Districts of Central Peru : J. C. Pickering. *E. and M. J.*, 85, 1908, 997. Morococha district next largest camp to Cerro de Pasco. Mines with production, copper contents, etc. Four custom smelters : two at Yauli, the Santa Barbara and the Carmen ; one on shore of Huacracocha lake and the largest, Backus and Johnston, at Casapalca. Equipment and smelting charges.

The Pacococha and Tamboraque smelter has a 40-ton water jacket furnace, Brown roaster, etc. New plant of the Peruvian M. S. and R. Co., at the Rio Blanco, will have a capacity of 200 tons per 24 hours.

The mines of Cajatamba are coal near Oyon, and metal, Quichos hacienda and near Chanca, ores from the latter treated at the Gasuna lixiviation plant by chloridizing roast and hypo leaching.

Smelting Works at Rio Blanco, Peru : M. and S. P., 96, 1908, 465. Peruvian M. S. and R. Co. 300 tons a day. Yielding 50–60 per cent. matte, shipped abroad. 44 × 186 in. blast furnace. Sintering plant of 12 one-ton pots. Sample mill, Vezin sampler, 60 tons an hour.

The Great Cobar Smelting Works: *E. and M. J.*, 85, 1908, 950. The new copper smelter at Cobar, Australia. Three blast furnaces, about 3,000 tons a day capacity. Sections and description of sampling works, plan of furnace building, blast furnaces and converters with several photographs. Furnaces 56 × 240 in. Two converter stands, 84 × 126 in. converters.

Cobar Gold and Copper Field, New South Wales : G. W. Williams. *E. and M. J.*, 86, 1908, 957. Great Cobar copper mines. Three blast furnaces. First matte 24 per cent. Cu : concentrated to 40 per cent. Shipped to Lithgow plant, which has 17 reverberatories, 4 of which are used for refining. Electrolytic plant.

Cobar gold mine 100 stamps. Occidental mine 60 stamps.

Gold and Silver.

Gold-Dredging Practice in California : R. Sibley. *E. and M. J.*, 85, 1908, 1082. Methods at Oroville and Yuba City, Cal. Power, cost, and equipment. Problems in operation.

Dredging in the Yukon : T. A. Rickard. *M. and S. P.*, 96, 1908, 290, 354. First dredge was that of the Lewes River Mining and Dredging Co. The Canadian Klondike Co. Yukon Gold Co. Method of thawing ground, etc.

Dredging on the Seward Peninsula : T. A. Rickard. *M. and S. P.*, 96, 1908, 734. Description of various dredges near Nome, reasons for failure. The Three Friends dredge, a successful operation.

La Grange Hydraulic Mine : D. F. Campbell. *M. and S. P.*, 96, 1908, 491. In center of Trinity Co., Cal. Plan of operations, sluice

lining. First 8 boxes (96 ft.) lined with rails longitudinally, the rest with transverse steel rails kept apart by cast-iron lugs. A set of 40-lb. rails wears out in 6 months.

San Antonio de Poto Hydraulic Mine, Peru: W. E. G. Firebrace. *M. and S. P.*, 96, 1908, 780. 15,600 ft. above sea level. 2 monitors, 4 in. nozzle: under 125 ft. head. Flume 160 meters, 6 per cent. grade, stone paving.

Deep Lead Mining in Australia: D. H. Browne. *M. and S. P.*, 96, 1908, 565. History. Australian circular cast-iron puddling machine. Methods in Ruthergla district. The Berry United Deep Lead Ltd. installing belt conveyors to elevate puddled dirt. Pumping engines. Mining, trouble from water.

The San Juan Region, Colorado: T. T. Read. *M. and S. P.*, 96, 1908, 632. Historical. Geology. Creede. Ouray. The Camp Bird. Telluride. The Liberty Bell. Silverton. Ores and concentrate shipped to Durango, Pueblo, Leadville and Salida. Lewis and Bartlett process at Canyon City.

Reminiscences of the Early Rand: M. H. Combe. *J. Chem. Met. and M. Soc. S. A.*, IX., 1908, 38. Early work in 1887. Wages. Aurora G. M. Co. Discussed p. 123 by J. S. Curtis and others.

Some of the Large Stamp Mills of the World, I.: C. C. Christensen. *Min. World*, 29, 1908, 553, II., 803. Alaska Treadwell and Alaska Mexican mills. Homestake mills, S. Dakota.

Relation of the Percentage of Retort Metal in Amalgam to the Gold Fineness in the Retort Metal: J. H. Haynes. *West. Chem. and Met.*, IV., 1908, 200. Chart showing relation of gold fineness in retort metal to percentage of retort metal in amalgam. Theoretical gold line taking amalgam as a mixture of $AgHg_2$ and AuHg: that supposing we are dealing with $AgHg_2$ and $AuHg_2$. Actual gold line from practical work is a curve. From this the percentage of retort metal being known, the gold fineness can be found.

Proper Way to Clean and Dress Plates during Amalgamation: J. H. Haynes. *West. Chem. and Met.*, IV., 1908, 233. Best work when amalgam rough. Curves showing variation of extraction with time from clean up. Influence of crushing in cyanide.

Chlorination in California: W. E. Darrow. *M. and S. P.*, 96, 1908, 609. The early methods, losses. Modern vat process. Greenawalt process, roasting in mechanical furnaces, cool, charge into vats, wash with saline chlorine solution (electrically generated chlorine gas). Ag, Pb, Cu and Au dissolved. Electrolytic precipitation on lead shavings for gold. Solution electrolyzed and other metals recovered, solution regenerated.

The Portland Mine in Cripple Creek District: C. P. Scates. *Min. World*, 29, 1908, 699. History and development. Mining. Mill at Colorado City. Chlorinates crude ore and cyanides tailings.

The Mt. Morgan Mine: O. M. Colvocoresses. *M. and M.*, 29, 1908, 3, abs. from *Yale Sci. Monthly*. History. Geology. Gold ore by chlorination process. Copper ore smelted in blast furnace, converted and refined electrolytically.

Improved Process for Extracting Metals in Ores: W. E. Greenawalt. *Min. World*, 29, 1908, 849. Greenawalt chlorination process described.

Concentration of Slimes: E. A. Sperry. *West. Chem. and Met.*, IV., 1908, 191, 207, 223, 247. Deals with crushing and grinding. Sizing. Classification. Dewatering and final treatment. Classification of machines and apparatus.

Tube Mill Crushing: E. B. Wilson. *M. and M.*, 29, 1908, 8. Use of tube mills for crushing to slime in cyanide process. Various styles of mills. Abbé. Krupp.

Cyaniding Slime: E. B. Wilson. *M. and M.*, 29, 1908, 59, 129, 187, 224. Decantation process. Sand distributors. Agitators. Adair-Usher process. Nicholls slime process. The filter press. Sweetland press. Blaisdell pressure filter. Kelley filter. Moore vacuum filter. Butters filter.

Filtration of Slimes at El Oro, Mexico: E. L. H. Forbes. *E. and M. J.*, 86, 1908, 458. Description of Burt filter. Method of operation. Cost. Drawings.

The Butters Vacuum Filter: C. H. Clevenger. *M. and M.*, 28, 1908, 574. General principles of slime washing. Description of the Butters filter. (1) Gravity plant, (2) semi-gravity plant, (3) pumping plant. Operation of the filter.

An Improved Press for Filtering Cyanide Slimes: E. J. Sweetland. *Min. World*, 29, 1908, 565. Description and illustrations of Sweetland press for cyanide process.

Continuous Slime Filter: R. Schorr. *M. and S. P.*, 96, 1908, 194. Description with illustrations of Schorr's continuous slime filter.

Continuous Vacuum Filter Machine: B. Hunt. *M. and S. P.*, 96, 1908, 430. Describes the Hunt continuous slime filter, with drawings.

Operation Costs of the Merrill Press at the Homestake Slime Plant, Deadwood, S. Dak.: M. and M., 29, 1908, 141. Operating costs per ton itemized. Total, 25c. per ton.

Agitation by Compressed Air: F. C. Brown. *M. and S. P.*, 96, 1908, 424. Notes a New Zealand experience with "B. and M." tanks (Brown and McMiken), the "Pachuca" tank of Mexico. Drawing of apparatus.

Apparatus for Extracting and Filtering Ore: J. E. Porter and A. L. Clark. *Min. World*, 29, 1908, 401. For low grade refractory sulphide ores. Tank with false bottom. Adjustable porous cylinders with pipe connections, attached to frame, which can be raised or lowered. Steam coil for heating. Air agitation. Method of work.

The Adair-Usher Process: A. Adair. *J. Chem. Met. and M. Soc. S. A.*, VIII., 1908, 331. Use of umber in slimes. The Usher washing apparatus. All sliming. Examples of experiments.

Laboratory Tests on the Use of Coarse and Fine Lime for Cyaniding: W. J. Sharwood. *J. Chem. Met. and M. Soc. S. A.*, VIII., 1908, 293. Experiments to ascertain relative rapidity of dissolution of commercial lime in varying states of division, in an inert charge, subjected to percolation of water or cyanide solution.

Precipitation and Clean-up at the Kendall Mill, Kendall, Montana: E. B. Coolidge. *West. Chem. and Met.*, IV., 1908, 214. Mill uses dry crushing. Ore runs $3–$8 per ton. Zinc shavings precipitation. Method of clean-up given.

Zinc Dust Precipitation at Cerro Prieto: R. Linton. *J. Chem. Met. and M. Soc. S. A.*, IX., 1908, 74. Black Mt. M. Co., Magdalena, Sonora. Mill methods. Zinc press of Dehne type. Advantages and disadvantages of process.

Battery and Cyanide Gold Smelting: A. Thomas. *J. Chem. Met. and M. Soc. S. A.*, IX., 1908, 1. A brief outline of some present practices. Retorts. No. 40 plumbago crucibles. Borax flux. Calcining zinc gold slime. Smelting. Fluxes. Furnaces.

Bromo-Cyaniding of Gold Ores: E. W. Nardin. *M. and S. P.*, 96, 1908, 562. Process as carried out at Hannan's Star plant, erected by London-Hamburgh Co. Dry crushing in Krupp ball mills. Amalgamated plates. Mixer. Classifier and tube mill. Agitator vats. KCy treatment followed by BrCy. Reactions involved. Tests.

Mantana-Tonopah Stamp and Cyanide Mill: E. and M. J., 85, 1908, 959. Battery of 40 stamps, 200 tons a day. Classified into sand and slime. Sand is concentrated on tables, ground to slime in 2 tube-mills, reconcentrated with slime from the classifiers on Frue vanners. Tails are a slime, 85 per cent. passing 200 mesh. Agitation and vacuum filters. Zinc dust precipitation. Concentrate and precipitate shipped to smelters. Operating costs $3.50 per ton. 90 per cent. extraction. Ore runs 20 oz. Ag. $4 gold per ton. Total time in agitators 30 hours. No sand treatment. Plans and elevation of mills.

Milling Plant of the Montana-Tonopah Mining Co.: G. H. Rotherham. *M. and S. P.*, 96, 1908, 324. 40 stamps through 20 mesh in cyanide solution. Cone classifiers. 8 wilfleys. 2 Dorr classifiers. 2 Allis-Chalmers tube mills. Classified. Frue vanners. Settlers. Six Hendryx agitators. Butters filters. Zinc dust and Merrill precipitation presses. Costs. Cyanide consumption.

The Goldfield Consolidated 600-ton Mill: P. E. Barbour. *E. and M. J.*, 86, 1908, 467. Description of new plant with drawings. Batteries. Tube mills and concentrators. Pachuca agitators. Butters gravity vacuum filter. Zinc dust and Merrill filters.

Mining and Milling at Virginia City, Nevada: G. E. Walcott. *Min. World*, 29, 1908, 771. Mining and pumping. Milling. Butters plant. Yellow Jacket mill.

Nickel Plate Mine and Mill in B. C.: C. A. Alphonson. *Min. World*, 28, 1908, 861. Similkameen district. The ore. Stamps, plates, Frue vanners, cyanide, sand and slime tanks.

The Great Boulder Perseverance Mine: E. and M. J., 86, 1908, 224. Some costs given. Treatment chart, showing method using Griffin mills, roasting in Perseverance furnaces, cyanide with filter-presses.

Conveyor System at the New Kleinfortein Mill: E. J. Way. *E. and M. J.*, 85, 1908, 887. The predominant factor in the entire design of

the new surface equipment was the replacement of colored labor by the most up-to-date labor-saving appliances. Method of hauling coal and ashes by Robins belts and bucket elevators; chain-grate mechanical stokers; ash storage bins above waste belt. Three shafts; main ore bin at Central. Conveyor to crusher station, thence to mill bins. The new 200-ton stamp mill treats 47,000 tons a month. Ten sand-treatment tanks in two rows. Two belt conveyors below lead to the main waste conveyor. Blake-Dennison weighing machines, etc. Plan of works shows system of belts from crushers to mill, thence to cyanide plant. Slimes plant. Dump with distributor. Cost sheet.

Gold Mining and Milling Practice in Tasmania: R. Stokes. *Min. World*, 29, 1908, 563. The Tasmania gold mine near Launceston. Mill of 2 sections, 40 and 65 stamps. Tables and canvas strakes. Classifiers. Part of product to jigs, concentrates for chlorination, tails for cyanide: part to wilfleys, concentrates are chlorinated; part to Luhrig vanners. Concentrates roasted in 4 Edwards furnaces. 36 chlorinating vats. Wages, etc.

Cyanidation in the Malay States: H. F. Lofts. *J. Chem. Met. and M. Soc. S. A.*, VIII., 1908, 341. Raub Australian gold mine at Raub Pahang. Quartz ore containing Scheelite, Sb, Bi and As as pyrite. Tails run 1.12 dwt. cannot be treated. When concentrated in wilfleys, treated as slimes, 78 per cent. extraction. Sb the cause of trouble.

Recent Cyanide Practice in Korea: A. E. Drucker. *M. and S. P.*, 96, 1908, 458. Oriental Consolidated M. Co. has 5 stamp mills and 4 cyanide plants. At Candlestick there is a small mine 20–30 tons of $20 ore a day. 7 × 10 in. Blake crusher, 10 stamps 1,050 lbs. 2 standard 10 ft. copper plates. 2 inside plates. In cyanide plant 4 pyramidal pulp thickeners 7 × 7 × 5 ft. 4 mechanical agitators, 1 vacuum filter, 4 sand filter clarifying tanks, 6 eight-compartment zinc boxes. Method of work. Section of plant.

Cyanidation in Mexico: F. J. Hobson. *M. and S. P.*, 96, 1908, 159, 182. Notes on early work. The first cyanide plants. Adaptability of process to silver ores. Chemical reactions. Mercurous potassic cyanide dissolves silver minerals.

Silver Cyaniding in Mexico: J. B. Empson. *E. and M. J.*, 86, 1908, 667. Some notes on mining costs, rapid cyaniding by agitation and aëration. Electric precipitation.

Rejuvenation of Guanajuato Camp, Mexico: T. C. Welch. *Min. World*, 29, 1908, 519. Old and new methods, mines, mills and equipment.

Guanajuato, the Great Silver Camp of Mexico: C. T. Rice. *E. and M. J.*, 86, 1908, 669. The mines of the district. Veta Madre. History. Production. Geology. Wages, etc.

Jesus Maria and Flores Mills, Guanajuato: C. T. Rice. *E. and M. J.*, 86, 1908, 615. The Jesus Maria is at La Luz. Built for custom work as well as own ore. 100 stamps, plates. Dorr classifiers. Twenty No. 3 wilfleys. Sand plant with Blaisdell-Butters equipment. Bustos mill and Flores cyanide plant, Butters filter. Zinc shavings precipitation.

Cyanide Mills, Guanajuato Development Co.: C. T. Rice. *E. and M. J.*, 86, 1908, 947, 997. The Mayal mill, San Prospero, Peregrina and Penguico mills. Methods of treatment.

The New Esperanza Mill at El Oro, Mexico: C. T. Rice. *E. and M. J.*, 86, 1908, 760. In the remodeled mill the oxidized ore will be crushed in the stamp batteries (120 stamps) while the sulphide will be crushed in the Huntington mills (13). They will be concentrated by Frue vanners and wilfleys respectively. Esperanza Drag classifiers. Slime treated in 6 Pachuca tanks. Sands and tailings from dumps to 10 Krupp tube mills, classified, slime to 6 Pachuca tanks. Merrill filter presses. Zinc dust precipitation and Merrill precipitate presses. Flow sheet of remodeled mill given.

Some Metallurgical Processes at Pachuca, Mex.: C. T. Rice. *E. and M. J.*, 86, 1908, 559. Patio, pan, Kröncke and cyanide processes in operation. Patio at the Guadalupe hacienda, 1,000 tons ore a week. Progreso mill uses pan amalgamation. La Union the Kröncke process is to be replaced by cyanide. Blaizdell Coscotitlan syndicate treats the old tailings.

Cyanidation of Silver Ores, Pachuca, Mexico: C. T. Rice. *E. and M. J.*, 86, 1908, 647. Practice at the Guerrero mill. Storage bins 2,000 tons. Snyder samplers. Stamp mill, eight 5-stamp batteries. Crush in 0.05 per cent. KCN. Callow cones and screens. Evans-Waddell Chilean mills. Classifiers. Wilfleys, and Johnston vanners. Dorr classifiers and Abbé tube mills. Cyanide plant, 24 treatment tanks 10 × 38 ft. deep, mechanical agitation. Addition of ⅓ kg. lead acetate per ton dry slime during first agitation. Decantation and clarifying tanks. Zinc box precipitation. Butters' filter being installed.

Loreto mill. 40 stamps, 14 Chilean mills, 3 tube mills, 2 Abbé, 1 Krupp, Johnston tables, cyanide plant has Butters' filter.

San Francisco No. 1 mill. Custom ores. 500 tons per week. 30 stamps. Wilfleys. Frenier sand pumps to classifying cones. Slime to Pachuca tanks, sand to tube mill. Two Butters' filters. 10 zinc boxes.

San Rafael mill now being erected, 250 ton. 60 stamps. 3 Krupp mills. 10 Pachuca tanks. Burt clarifier. 2 Moore filters. Concentration on wilfleys.

The San Rafael Mill at Pachuca: M. R. Lamb. *E. and M. J.*, 86, 1908, 325. 60-stamp mill being built. Crush in cyanide. Coarse pulp from battery, after classification, to tube mills, slime to settlers. 3 continuous Dorr settling tanks. Thick material to 10 Brown tanks, agitation by air. Settling tanks. Moore filter.

Metallurgical Practice at Hacienda de la Union: F. Narvaez. *E. and M. J.*, 86, 1908, 989. A custom mill in the city of Pachuca. Barrel amalgamation to be replaced by cyanide with tank agitation. Chilean mills for fine grinding.

Veta Colorado Cyanide Mill, Parral, Mexico: C. T. Rice. *E. and M. J.*, 86, 1908, 120. Ore from mine goes to an 800-ton bin. 2 Blake crushers 24 × 12 in. 2 crushers 9 × 15 in. Sampling. Blake-Dennison weighing. Battery bins 1,150 tons. Challenge feeders to 80

stamps: 16 cone classifiers. Overflow to 16 cones then 8 card tables. Underflow to 8 wilfleys. Tails from both sets of tables to 8 Wheeler pans then 8 card tables. Tails to 4 cones, underflow to 5 tube mills 14 × 5 ft. Settler 90 × 40 × 6 ft. 14 Pachuca tanks. Feed tank with agitator. 10 Ridgway filters. Precipitation boxes. Solution pumped to battery sump tank.

El Rayo Gold Mine, Near Santa Barbara, Mex.: C. T. Rice. *E. and M. J.*, 86, 1908, 78. Occurrence of ore, development. Mill treatment. Blake crusher, roughing and finishing rolls to 8-mesh. Huntington mills through 50-mesh. Frue vanners. Tails separated into sands and slimes and cyanided. Butters and Mein distributors. Merrill automatic discharge slime press and Butters filter. Zinc dust precipitation.

Zacatecas, a Famous Silver Camp of Mexico: C. T. Rice. *E. and M. J.*, 86, 1908, 401. History, Geology, etc. The Bote pan-amalgamation mill. Installation of cyanide plants.

On Horseback in Western Chihuahua: M. R. Lamb. *E. and M. J.*, 86, 1908, 159. Visits to Concheno, Pinos Altos, Ocampo, Moris and El Socorro, Potrerito, Sahuayacancito and La Republica, the Palmarejo Company, Rio Plata, with short descriptions of plants, etc.

Mining in Mexico, Past and Present: E. A. H. Tays. *E. and M. J.*, 86, 1908, 665. Spanish search for precious metals. Mexican tradition. Early mining. Ore stealing. Patio process. Smelting silver ores.

Mexican Notes: Mark R. Lamb. *M. and S. P.*, 96, 1908, 702, 736. Hacienda Loreto changed from patio to cyanidation. Photographs of plant, of native copper furnace, an adobe smelter.

Hinds Consolidated Mines, Mexico: S. F. Shaw. *M. and S. P.*, 96, 1908, 598. Santa Barbara, Chihuahua. Mines. Mill, crushers, rolls, classifiers, jigs, concentrates to smelter. A complete regrinding and fine concentrating equipment ordered. Hardinge tube-mills. James slimers and tables. Present saving in the mill is 48 per cent. assay value.

Las Chispas Mines, Sonora, Mexico: B. E. Russell. *E. and M. J.*, 86, 1908, 1906. Minas Pedrazzini Co. Geology, ore, etc. Best ore shipped. Second-class ore treated by a combined concentration and pan-amalgamation process. Ore stealing.

Hacienda Buburon, an Old Mexican Silver Mill: M. R. Lamb. *E. and M. J.*, 86, 1908, 663. Description of old mill near La Luz, Guanajuato. Water power used, but river is now dry. 12 stamps. Arrastras. Patio now under gravel.

The Patio Process: C. P. Duarte. *J. Chem. Met. and M. Soc. S. A.*, IX., 1908, 105. History. Process. Theory. Reactions.

Decline and Revival of Comstock Mining, II.: W. Symmes. *M. and S. P.*, 96, 1908, 570. In early sixties many mines put up their own mills. Graft very much in evidence. "Low grading." Bullion output increased, till 1890 the Comstock was the liveliest mining camp in the West, but the low-grade ore was nearly exhausted. New

bonanzas caused jumps in stocks. Present methods of assessment and the like. Brokers, trustees have grown wealthy, while stockholders have been heavy losers.

Treatment Locally of the Ores of Topia, Mexico: T. C. Graham. *Min. World*, 29, 1908, 275. Analyses of ores. Hand-picked ore shipped. Part is jigged. Lead 60–75 per cent. Rich zinc to be shipped. Zinc high in iron leached at mill. Chloridizing roast. 0.3 per cent. hypo leach.

Electrolytic Refining of Gold, Silver and Copper at the U. S. Mint, San Francisco, Cal.: R. L. Whitehead. *Electro-Chem. and Met. Ind.*, VI., 1908, 355, 408. Wohlwill process for gold refining. Silver process. Removal of copper from solutions. Illustrations of tank room, pumps, switchboards, etc. Melting room, water-jacketed copper furnace, crucible melting furnace.

Electrolytic Gold Refining: E. Wohlwill. *Electro-Chem. and Met. Ind.*, VI., 1908, 450. Criticisms of J. W. Richard's calculations on electrolytic gold refining (VI., 114).

The Silver Refinery of the New Addition to the Raritan Copper Works: E. D. Easterbrooks. *Electro-Chem. and Met. Ind.*, VI., 1908, 277. Description with plans of silver refinery, slime room, furnace room, parting plant, sulphate building, etc.

Dredging for Platinum in the Urals, Russia. L. Tovey. *E. and M. J.*, 86, 1908, 701. Two main districts for platinum, the Nijni Tagilsk, and on the river Iss, tributary to the Tura. Methods of operation.

Iron and Steel.

Practical Blast Furnace Management. R. Bolling. *E. and M. J.*, 85, 1908, 989. Photographs of blast furnace plant and pig casting machine (Nova Scotia Steel Coal Co., Sydney mines, N. S.). Contrasts old and new methods. Chemical laboratory. Calculating the burden.

The Shape of the Iron Blast Furnace: H. M. Howe. *E. and M. J.*, 86, 1908, 508. Discussion of factors determining shape and dimensions. Angle of bosh. Diameter at tuyeres and at top.

Dry Blast Plant of the Illinois Steel Co.'s South Works: Electro-Chem. and Met. Ind., VI., 1908, 513. Gayley process. Cooling apparatus, ammonia compressors. Method of distributing ammonia. Diagram of plant.

Iron Operations in N.E. Alabama: E. Higgins. *E. and M. J.*, 86, 1908, 1083. Alabama Con. Coal and Iron Co. Attalla Clinton red hematite mines. Fe 44–50, Phos 0.3 in soft ore, Fe 39–44, Phos 0.4 in hard ore. Brown-ore mines at Ironaton. Fe 46–52, Phos 0.2 or less. Log washers. Coke and limestone. Gadsden furnace. 2 stacks. Brown tops. Make standard foundry pig. 200–225 tons each. Ironaton furnaces. 2 stacks. Baker top. 125–150 tons each. Several photographs.

The New Steel Corporation Plant at Gary: E. and M. J., 86, 1908, 1253. 23 miles S.E. of Chicago. 5 Hulett unloaders and Hoover

and Mason bridges. 8 blast furnaces built, each 500 tons a day. 8 to be constructed. 84 open hearth furnaces, in units of 14. 70 ton furnaces. Rail mill 4,000 tons daily. 12 sets of roll trains. Billet mill.

Iron Operations of the Birmingham District: E. Higgins. *E. and M. J.*, 86, 1908, 1043. District ranks second in U. S. Clinton ores, etc. Mining. Coke and limestone. Furnace burden and quality of pig. Smelting operations in the district.

Iron and Zinc in S. W. Virginia: E. and M. J., 86, 1908, 908. Notes regarding Virginia Iron, Coal and Coke Co. Pulaski Mining Co. Bertha Mineral Co.

Iron, Steel and Fuel in China: W. D. B. Dodson. *M. and S. P.*, 96, 1908, 494. Sheng Kung Pao has reorganized the Hanyang Iron and Steel Works, the Tayeh Iron Co. and the Pinghsiang collieries. The steel plant and rolling mill have 1,000 tons daily capacity, furnace plant of 800 tons capacity.

Electrosidérurgie: C. Le Chatelier. *Rev. de Met.*, 5, 85. Steel furnaces, Girod, Héroult, Keller, Kjellin, Stassano: Cast iron, Héroult, Keller: Ferrous alloys, Girod, Héroult, Keller. Descriptions and illustrations. Bibliography 19 titles.

Electric Steel Furnaces in Europe: Electro-Chem. and Met. Ind., VI., 1908, 469. From *Stahl und Eisen*, Oct. 7, 1908. Sixteen Héroult, 11 Stassano, 1 Keller, 2 Du Giffre, 10 Girod, 12 Kjellin, 10 Röchling-Rodenhouser, 1 Schneider, 3 Frick and 3 A. G. Electromet. Ludwika. Charge and power given.

The Girod Electric Steel Furnace: Electro-Chem. and Met. Ind., VI., 1908, 428. Description, with drawing of 2-ton furnace.

Treatment of Iron and Steel in the Electric Furnace: E. Stassano. *Electro-Chem. and Met. Ind.*, VI., 1908, 315. Results of treatment of iron ores and agglomerates. Illustrations and photographs. Tables.

Experimental Electric Smelting: L. D. Farnsworth. *Electro-Chem. and Met. Ind.*, VI., 1908, 326. Experiments at Stanford University to learn some of the fundamental principles and data.

Steel Hardening Furnace: Electro-Chem. and Met. Ind., VI., 1908, 410. Abstract of paper by Straube, *Electrotech. Zeits.*, Aug. 6, 1908. A firebrick crucible, two opposite sides of which contain iron electrodes. Molten electrolyte. KCl melts at 775° C. $BaCl_2$ melts at 950° C. For temperatures between 200° and 400° C. use potassium and sodium nitrate. Between 1300° and 1600° use fluospar and magnesium fluoride. Drawing showing furnace and pyrometer in place.

A Laboratory Experiment to Illustrate the Changes in Magnetic Properties Occurring at the Thermal Critical Points in Steel: H. M. Boylston. *Electro-Chem. and Met. Ind.*, VI., 1908, 273, 321. Description of apparatus, an electro-magnet, Le Chatelier couple, test-piece holder. Loss of magnetism at $Ac_{3\text{-}2\text{-}1}$ in high-carbon steels and Ac_2 in low-carbon steels.

Carbon and the Properties of Cast Iron: H. M. Howe. *E. and M. J.*, 86, 1908, 943. Influence of carbon condition on hardness,

strength, etc. Graphite and cementite. Means of control. Influence of S, Mn, P.

Calcium Silicide for the Purification of Metals, Particularly Steel: H. Goldschmidt. *Electro-Chem. and Met. Ind.*, VI., 1908, 244. In steel making the addition of Al yields Al_2O_3, whose melting point is above 1800° C., which does not separate out completely in the slag. Using calcium silicide, calcium sulphide is formed and the silicon is oxidized and forms a highly liquid slag with the oxides present.

LEAD.

Ore Contracts from the Smelter's Standpoint: C. A. Grabill. *E. and M. J.*, 86, 1908, 73. A reply to article by H. M. Adkinson. Eight independent variables, prices of lead and silver, percentages of lead, silver, gold, insoluble, iron and sulphur. Principles involved in calculating smelting costs. Smelting losses, etc.

Ore Contracts from a Producer's Point of View: H. M. Adkinson. *E. and M. J.*, 85, 1908, 992. Discusses how ore contracts are made. Data required. Examples of contracts contrasted and the benefit of competition.

The Cost of Silver-Lead Smelting: W. R. Ingalls. *E. and M. J.*, 86, 1908, 315. Data taken from the reports of the American Smelting and Refining Co. Cost of smelting per ton of charge ranged from $2.50 to $4.80, average $3.60 for 9 plants. Cost of roasting $2 to $2.50 per ton of ore roasted. Smelters reckon it costs about 25c. per unit to get rid of sulphur and for every ton of charge smelted in the blast furnace about 0.4 ton of material (ore and matte) must be roasted which adds say 80c. per ton to cost of smelting. The latter is about $2.50 plus 16c. for administration account. Total $2.66. If ore amounts to 80 per cent., cost per ton of ore is $3.33. Add 80c. = $4.13 per ton of ore. Figuring on 80 per cent. of ore the $3.60 above becomes $4.50 per ton of ore approximately. Interest charges, amortization, etc., have to be added. Freight and refining. Tonnage of ore smelted. Increase in profits. Policy of the company. Division of ore value. Conclusions.

Costs and Profits in Silver-Lead Ore Production: J. R. Finlay. *E. and M. J.*, 85, 1908, 1279. Factors governing costs of mining, smelting and marketing. Cœur d'Alene, Broken Hill, Park City.

Cost of Lead Mining and Smelting in Spain: E. and M. J., 86, 1908, 329. Report of Linares Lead Mining Co. for year ending June, 1907. Working on a small scale: hand dressing to a high grade product: smelting in reverberatories. Some ore calcined and smelted in blast furnace with slags and fume also dross from desilverizing pots.

Zinc and Lead Smelting in Silesia: J. S. G. Primrose. *E. and M. J.*, 86, 1908, 265. Roasting, multiple hearth muffle type. At the Walter Croneckhütte near Rosdzin are 20 blocks of Hasenclevers, 4 furnaces to a block, end fired, three hearths high. Calamine calcined in hand reverberatories. Acid recovery. Distillation furnaces; Siemens open bottom producers the rule, with three high Siemens-Belgian

furnaces. Counter-current recuperation installed at the Silesiahütte. Muffle making, etc. Cadmium smelting. Lead smelting at the Friedrichshütte, Tarnowitz using the H. and H. process. Parkes process of desilverizing.

Metallurgy of Broken Hill, New South Wales: G. B. Williams. *E. and M. J.*, 86, 1908, 893. General method of dressing. Crushers. Cornish rolls. Jigs. Ball mills or pans for jig tailings and resulting sands returned to jigs and tables. Proprietary mine. Central mine. Tailings plant. Broken Hill South. North Broken Hill mill.

Mining in Zeehan Silver-Lead Field, Tasmania: R. Stokes. *Min. World*, 28, 1908, 911. Location, wages. Mills. Tasmanian Smelting Co. H. and H. process. Low grade sulphide ore: Zn 30 per cent. Pb 10 per cent. S 35 per cent. Ag 10 oz. 2 blast furnaces, 100 tons each per day for 10 tons bullion.

A Peruvian Lead Smelter: L. W. Strauss. *M. and S. P.*, 96, 1908, 361. Smelter at Vesubio, 135 miles from coast. 2 hand reverberatory roasters. Circular blast furnace. Runs with hot top and losses are very high.

Smelter of Penoles Co., Mapimi, Mex.: C. T. Rice. *E. and M. J.*, 86, 1908, 373. H. and H. roasting. Mechanical charging of blast furnaces. Six 162 × 46 in. furnaces. Robinson air-tight tuyeres. Movable slag pot instead of forehearth. Small reverberatory settler of 80 tons capacity. Treatment of employees.

Treatment of Sulphide Ores by the Huntington-Heberlein Process: L. S. Austin. *M. and S. P.*, 96, 1908, 641. Costs given total $1.02 per ton, while the long hand reverberatory roasting costs $2.00 and 60c for bricking.

Blast Furnace Gases in Silver-Lead Smelting: L. S. Austin. *M. and S. P.*, 96, 1908, 364. Notes on some tests made in 1893 by T. S. Austin at the Gran Fundicion Nacional Mexicana, Monterey, Mex.

The Cottrell Fume-Condensing System at the Selby Smeltery: E. and M. J., 86, 1908, 242. Bag house with woolen bags for blast furnaces. The Cottrell process is used on the parting plant and will be applied to the roasters.

Cottrell Process for Condensing Smelter Fumes: E. and M. J., 86, 1908, 375. Separates finely divided particles of solids or liquids originally held in suspension in bodies of gas or vapor by the application of electric charges. Description of apparatus and method of operation with illustrations.

Bag House of U. S. Smelter in Utah: H. E. Benedict. *Min. World*, 29, 1908, 633. Construction and arrangement, illustrated. Apparatus for shaking bags.

The Bag House at Selby, California: J. C. Bennett. *E. and M. J.*, 86, 1908, 451. Reinforced concrete building. Capacity of plant, gases from two silver-lead blast furnaces, 36 × 144 in., smelting 360 tons per 24 hours. 3 cupel furnaces. 1 sweating furnace. To these were to be added two 60-ton softeners and two 60-ton refining furnaces. Provision for a third blast furnace. Plan, elevation, section and detail drawings given.

Handling Blast Furnace Bullion at the Selby Smelting Works: J. C. Bennett. *E. and M. J.*, 86, 1908, 83. Beneath lead-well spout a pot stands on a track. When full it is drawn away and another one takes its place. Two sets of moulds by side of track, into which the lead is poured by tilting the pot. Plan and drawings show details.

From Mine to Battleship: T. A. Rickard. *M. and S. P.*, 96, 1908, 622. The story of the manufacture of white-lead paint. Bunker Hill and Sullivan mine. Milling. Smelting. Selby Smelting and Lead Co. at Vallejo Junction. Bins. Blast furnace 36 × 144 in. 130 to 140 tons charge a day. Charge 2,500 lbs. Briquetted slime (pure Bunker Hill, mixed with roasted ore and siliceous Tonopah or Goldfield fines and bricked in Boyd press), 1,100 lbs. roasted matte, 1,000 lbs. limestone, 800 lbs. siliceous ore, 800 lbs. lead ore, 300 lbs. refining by-products, 200 lbs. scrap iron, 1,000 lbs. coke (Australia). Slag runs 31 SiO_2, 35 FeO, 18.5 CaO, 7 Al_2O_3. Three 90-ft. Ropp's, one 150 ft. Desilverizing dep't. Four liquating kettles. Softeners. Four desilverizing kettles. 70-ton refining reverberatory. Manufacture of sheet lead, shot and white lead by Dutch process. Specifications for white lead. Several illustrations, including two excellent photos of cruisers.

Making Zinc-Lead White at Canyon City: Min. World, 29, 1908, 167. Description of plant. Good photograph of plant, of zinc furnaces, barreling machine, bag-house bins.

Smelting Practice at Granby Works, Missouri: E. W. Buskett. *Min. World*, 29, 1908, 917. Five Jumbo furnaces in operation. Blue fume chamber. Bag house.

Zinc.

Production and Consumption of Zinc in 1907: W. R. Ingalls. *E. and M. J.*, 85, 1908, 1183. Table of production for 1906 and 1907 by states. Increase in smelting capacity, new works. Table giving name of company, location, furnaces and retorts. Map showing situation of chief zinc districts of the U. S.

Zinc Smelting for Pigment: E. W. Buskett. *M. and S. P.*, 96, 1908, 604. Wetherill process. Zinc-lead ores treated at Canyon City, Colo., and Coffeyville, Kansas, for zinc-lead paint. Description of Coffeyville plant. Crusher and sampler, 2 McDougal furnaces, 2 blocks of 18 furnaces, combustion chambers, cooling pipes, fans and bag house.

The Gin Electric Furnace for Zinc Smelting: E. and M. J., 85, 1908, 1153. Electrical induction furnace. Primary of copper wire, secondary circuit a bath of molten iron contained in the two distillation chambers.

Fuels and Refractories.

Chemical Control of Coal Washers: R. Bolling. *E. and M. J.*, 86, 1908, 424. Feldspar jig. System at Nova Scotia Steel and Coal Co., Sydney mines described.

Jones and Laughlin's Coke Plant: W. L. Affelder. *M. and M.*, 29, 1908, 195. Plant of 1,500 bee-hive ovens in double blocks of 100 each. Ten experimental rectangular ovens. Hebb coke drawer.

A New System of Modern Coke Ovens: F. Tieschi. *E. and M. J.*, 86, 1908, 378. Superiority of ovens with regenerators. Uniformity of heating. Regulation. The new system. Advantages.

The Use of Refractory Brick in Metallurgy: F. T. Havard. *E. and M. J.*, 86, 1908, 802. Reverberatory copper, lead, cupel and antimony furnaces. The magnesite industry and sources. The chromite industry.

GENERAL.

Metallurgical Calculations: J. W. Richards. *Electro-Chem. and Met. Ind.*, VI., 1908, 195. The Mettallurgy of Zinc, II. Reduction of zinc oxide. Distillation of the charge. Electric smelting of zinc ores. *Page 250*, condensation of zinc; *p. 275*, condensation of zinc and mercury vapors; *p. 322*, metallurgy of aluminium.

Grinding: O. Nagel. *Electro-Chem. and Met. Ind.*, VI., 1908, 371. Gyratory crushers, roll, stamp mill, ball mills, Griffin mills, Fuller mills, Kent pulverizer, Impact pulverizers, Aero pulverizers.

Separating Appliances: O. Nagel. *Electro-Chem. and Met. Ind.*, VI., 1908, 198, 287. Filter presses. Centrifugal separators. Presses, other filtering appliances. Separation by crystallization, extraction and sublimation. Separation by settling and freezing.

Roasting Furnaces: O. Nagel. *Electro-Chem. and Met. Ind.*, VI., 1908, 455. Description of furnaces with drawings of Brown, Wethey, White-Howell, McDougall, Herreshoff and Wedge furnaces.

The Plant of the Michigan Copper and Brass Co.: Metal. Industry, VI., 1908, 303. At Detroit, Mich. Description of mill with illustrations.

Design for a Model Brass Foundry: Metal. Industry, VI., 1908, 341. Capacity 1 ton a day. Four melting furnaces. Core oven. Plan and elevation of building.

Magnalium, an Alloy of Aluminium and Magnesium: E. and M. J., 86, 1908, 526. Contains 90 to 98 per cent. Al. Can be forged and soldered easily. Sp. gr. 2.5. M. Pt, 1185 to 1250° F. Tensile strength, castings 19,000 to 42,000 lbs. Tubing 74,000. (90 per cent. Al.) Electric and thermal conductivity 56 per cent. that of copper.

Notes on Phosphor Bronze: A. Philip. *Metal. Industry*, VI., 1908, 373. Composition Cu 90–92, Sn 7.4–9.7, P 0.3–0.6. Owes its value to network of copper phosphide.

New Thermit Reactions: H. Goldschmidt. *Electro-Chem. and Met. Ind.*, VI., 1908, 360. Calcium-silicon, magnesium-silicon, aluminium-calcium.

The Microscope in a Method of Analysis in Roasting Sulphur Telluride Ores: W. H. Davis. *West. Chem. and Met.*, IV., 1908, 137. Merton furnace. Samples of roasted material panned and examined under microscope. Sylvanite is first fused and assumes a spheroidal form. Shot begin to decompose in the order of segments of the sphere and not as a uniform penetration from the entire surface. Free gold left in spheroidal form.

The Ferrites, Compounds of an Iron Acid: J. S. C. Wells. *E. and M. J.*, 86, 1908, 420. Treatment of complex zinc ores. $ZnFe_2O_4$. Analogous compounds. Formation of ferrite of zinc in the laboratory. Temperature and contact. Ferrous ferrite, Fe_3O_4.

Properties of Certain Silicates: G. Stein. Sprechsaal, 1908, XLI., 199. Abs. *E. and M. J.*, 86, 1908, 906. Quartz became viscous at 1600° C. Liquid at 1750° C.

$BeSiO_3$.	Melting point	above		2000° C.
$MgSiO_3$	"	"	"	1565° C.
$CaSiO_3$	"	"	"	1512° C.
$FeSiO_3$	"	"	"	1500–1550° C.
$MnSiO_3$	"	"	"	1470–1500° C.
$ZnSiO_3$	"	"	"	1479° C.
$SrSiO_3$	"	"	"	1287° C.
$BaSiO_3$	"	"	"	1368° C.

METALLOGRAPHY, ETC.

Notes on Metallography: W. G. Haldane. *West. Chem. and Met.*, IV., 1908, 315. Description of apparatus. Preparation of material for examination. Applications of metallography.

Color Photography in Metallography: Révillon and Beauverie. *Rev. de Met.*, V., 1908, 885. Lumière process. Excellent photographs of phosphor bronze, brass, 20 per cent. nickel steel.

Methods of Obtaining Cooling Curves: G. K. Burgess. *Electro-Chem. and Met. Ind.*, VI., 1908, 366. Methods of thermal analysis. Time-temperature curves. Differential curves. Direct and inverse rate curves. Rapid cooling. Characteristics of cooling curves.

Cold Junction Temperature Corrections of Pt.PtRh. and Pt.PtIr Thermo-Electric Pyrometers: C. Offerhaus and E. H. Fischer. *Electro Chem. and Met. Ind.*, VI., 1908, 362. Calibration of five different couples. Effect of change of temperature of cold junction on E.M.F. Corrections for same.

The Effect of Rate of Cooling on the Composition of Solid Solutions: Lepkowski. *Zeits. anorg. Chem.*, 59, 285. Tin-bismuth eutectic 58 per cent. Bi, 136.5° C. Copper-silver eutectic 778° C. Supersaturated mischkrystalle.

Alloys of Aluminium: Portevin. *Rev. de Met.*, V., 274. Continuation of series. AlBi, AlCa, AlCd, AlCo, AlCu, AlFe, AlK, AlMg, AlNa, AlNi, AlPb, AlSn, AlTl.

The Alloys of Copper: M. A. Portevin. *Rev. de Met.*, V., 361. Cu-Bi, Cu-Ca, Cu-Cd, Cu-Co, Cu-Fe, Cu-Mg, Cu-Mn, Cu-Ni, Cu-P, Cu-Pd, Cu-Pt, Cu-Si, Cu-Te, Cu-Tl.

The Alloys of Iron: Portevin. *Rev. de Met.*, V., 535. Fe-Bi, Fe-Co, Fe-Cd, Fe-Mn, Fe-Ni, Fe-Pb, Fe-Pt, Fe-FeS, Fe-Si, Fe-Sn, Fe-Tl, Fe-Va, Fe-Va-Si, Fe-Zn.

The Alloys of Lead: Portevin. *Rev. de Met.*, V., 1908, 909. Pb-Ca, Pb-Co, Pb-Cr, Pb-In, Pb-K, Pb-Na, Pb-Pd, Pb-Pt, Pb-Sb, Pb-Tl.

Alloys of Manganese: Portevin. *Rev. de Met.*, V., 1908, 762. *Alloys of Magnesium*, p. 774. Mn-Ni, Mn-P, Mn-Sb, Mn-Si, Mn-Sn, Mg-Bi, Mg-Cd, Mg-K, Mg-Ni, Mg-Pb, Mg-Sb, Mg-Sn, Mg-Zn, Mg-Tl.

Alloys of Nickel: Portevin. *Rev. de Met.*, V., 1908, 938. Ni-Bi, Ni-Cd, Ni-Co, Ni-Cr, Ni-Sb, Ni-Si, Ni-Sn, Ni-Pb, Ni-Tl, Ni-Zn.

Recent Work on the Copper-Aluminium Alloys: L. Guillet. *Rev. de Met.*, V., 413. Review of previous work. Curves. Constituents discussed. Work of Carpenter and Edwards given, p. 425. Inst. Mech. Eng., Jan., 1907.

The Freezing-Point Diagram of Copper-Arsenic, and the Electric Conductivity of Arsenical Copper: K. Friedrich. *Metallurgie*, V., 1908, 529. Cu_3As, 71.8 per cent. Cu shows max. at 830° C. Cu with 4 per cent. As in solution and Cu_3As form a eutectic at 21 per cent. As and 685° C. Cu_5As_2, 67.9 per cent. Cu forms at 710° C. Second eutectic. No Cu_2As. Increase in resistance shows marked jog at 4 per cent. As.

Copper-Tin Alloys: Sackur and Pick. *Zeits. anorg. Chem.*, 58, 1908, 46. Measurement of electromotive force, etc. Cu_3Sn and Cu_6Sn_5 or Cu_2Sn.

Alloys of Antimony with Iron and with Cadmium: Kurnakow and Konstantinow. *Zeits. f. anorg. Chem.*, 58, 1908, 1. Curve for Fe.Sb given. Fe_3Sb_2, 1014° C. and Fe 1544° C. form eutectic at 1002° C. and 50.5 per cent. Sb. Curve from 41.17 per cent. Fe, 1014° C. falls to eutectic point 1.5 per cent. Fe at 628° C., with a reaction point at 7 per cent. Fe and 732° C., $3FeSb_2 = Fe_3Sb + 4Sb$.

The Cd.Sb curve shows a maximum at 52 per cent. Sb, 455° C., for CdSb and a eutectic at 60 per cent. Sb, 445° C. Reaction point at 36 per cent. Sb, 409° C., Cd_3Sb_2 forming. Stable and labile systems. Eutectic at 7.5 per cent. Sb and 290° C. Crystallography of the compounds.

The Alloys of Cobalt with Tin, Antimony, Lead, Bismuth, Thallium, Zinc, Cadmium, Chromium and Silicon: K. Lewkonja. *Zeits. anorg. Chem.*, 59, 293. Co and Sn form a compound Co_3Sn, 1150° C. Co and Co_3Sn form eutectic at 1095° C. and 36 per cent. Sn. Co_3Sn reacts with melt at 945° C. to form βCoSn. βCoSn changes to α at 526° C. Eutectic of αCoSn and Sn at 1 per cent. Sn and 229° C. Determination of magnetic changes.

Co and Sb form a compound CoSb, 67 per cent. Sb, 1191° C. CoSb and Co with 12.5 per cent. Sb in solution form a eutectic at 59 per cent. Sb and 1095° C. CoSb and the melt, 91 per cent. Sb, react to form $CoSb_2$ at 897.5° C. Eutectic of Sb and $CoSb_2$ at 98.5 per cent. Sb and 616° C. Magnetic changes, from 12.5 to 67 per cent. Sb at 930° C.

The curve for Co and Bi shows the solubility curve cutting the freezing-point curve at 7.3 per cent. and 94 per cent. Bi at 1345° C. Eutectic at 3.3 per cent. Co and 258° C.

The cobalt-zinc alloys up to 18.5 per cent. Co were made. $CoZn_4$ freezes at 873° C. Mischkristalle 18.5 — 13.4 per cent. Co. Eutectic 0.5 per cent. Co freezes at 413° C.

The Co.Cr curve shows a series of solid solutions, minimum at 47 per cent. Cr and 1334° C. Co freezes at 1547° C. The Co-rich series shows a change point at 1223° C. Magnetic change, Co at 1056° C. 15 per cent. Cr at 300° C.

The curve for Co and Si shows three maxima. Co_2Si at 1327°, CoSi at 1395°, $CoSi_2$ at 1305° C. (Si 1443° C.). Eutectic of Co (7.5 per cent. Si in solution) and Co_2Si occurs at 1204° C. and 16 per cent. Si. Eutectic of Co_2Si and CoSi at 1249° and 25.5 per cent. Si. At 1215° C. Co_3Si_2 forms in the solid. Between 32.5 and 49 per cent. Si the alloys are composed of CoSi and $CoSi_2$ (1277° C.). Eutectic of $CoSi_2$ and $CoSi_3$ at 1213° C. and 54 per cent. Si. Eutectic of Si (9 per cent. Co in solution) and $CoSi_3$ at 1236° C. and 62 per cent. Si. Magnetic changes up to 19.4 per cent. Si at 1040° C.

Table contrasting the 3 series of alloys of iron, cobalt and nickel with various metals.

Cobalt-Tin Alloys: Żemczużny and Belynsky. *Zeits. anorg. Chem.*, 50, 1908, 364. Co 1502° and Co_2Sn 1171°. Eutectic 1112°. CoSn forms at 927°: changes at 515°. Eutectic freezes at 222° C. (cp. Lewkonja).

Alloys of Nickel and Phosphorus: N. Konstantinow. *Zeits. anorg. Chem.*, 60, 1908, 405. Curve shows two maxima. Ni_5P_2 and Ni_2P at 1185° and 1112° C. At 960° C. $Ni_3P = Ni_5P_2$ + liquid 13.8 per cent. Ni_3P and Ni form a eutectic at 880° C. and 11 per cent. Ni_5P_2 and Ni_3P form a eutectic at 1108° and 20 per cent. P.

The Chromium and Manganese Alloys: G. Hindrichs. *Zeits. anorg. Chem.*, 59, 1908, 414. Tin-chromium, copper-chromium, silver-chromium, lead-chromium curves given. All show separation into two solutions. $AlCr_3$ forms mischkristelle with Cr. With Al two solutions form, 0–36 per cent. Cr.

Silver manganese separates out into two solutions. Al and Mn form Al_3Mn and $AlMn_3$. Two liquid solutions 14 and 42 per cent. Mn.

Constitution of the Zinc-Copper-Nickel Alloys: E. Tafel. *Metallurgie*, V., 1908, 343, 375. The binary systems copper-nickel, zinc-copper, zinc-nickel. The ternary diagram. $NiZn_3$.

The Alloys of Silicon and Silver: G. Arrivaut. *Rev. de Met.*, V., 1908, 932.

Silicon-Silver Alloys: G. Arrivaut. *Zeits. anorg. Chem.*, 60, 1908, 436. Silver and silicon 1415° C. form a eutectic at 830° C., 4.5 per cent. Si. Eutectic begins at 10 per cent. Ag.

Silicon-Aluminium Alloys: W. Fraenkel. *Zeits. anorg. Chem.*, 58, 1908, 154. Curve shows a simple eutectiferous series. Si 1412° C. and Al 652° C. Eutectic 10 per cent. Si 578° C.

The Freezing-Point Diagrams for Cu-Cu_2Se, Ag-Ag_2Se, and Pb-PbSe: Friedrich and Leroux. *Metallurgie*, V., 1908, 355. The copper eutectic occurs at 1063° C. and between 2 and 3 per cent. Se. Cu_2Se 1113° C. Ag_2Se 839° C. and Ag form 2 conjugate solutions. Constant temperature 890° C. PbSe 1088° C. freezes out in a groundmass of pure lead.

Meteoric Irons: Fraenkel and Tammann. *Zeits. anorg. Chem.*, 60, 1908, 417. Iron-nickel alloys. Damara iron 7.8 per cent. Ni. Effect of annealing on structure. Magnetic change. Toluka iron, 9 per cent. Ni.

Contribution to the Metallographic Study of Quenched Steels: Kourbatoff. *Rev. de Met.*, V., 704 (1908). Transformations of austenite. Troostite, sorbite de reveau, troosto-sorbite. Transformations of troostite. Tempering of blister (C 1.6 per cent., quenched at 1200° C.) in boiling methyl alcohol 66° C., water 100° C., naphthaline 218° C., etc. No change at 100° or under.

On the Quenching and Tempering of Iron and Steel: Ed. Maurer. *Rev. de Met.*, V., 1908, 711. Steels of 1.66, 1.2, 0.83, 0.4, 0.245 and 0.14 per cent. C. Tempering at 100° to 750° C. Density. Dilatation. Hardness. Electric resistance. Magnetism. Metallography. Thermal work. Other steels used.

Experiments on the Freezing and Melting of Commercial Cast Iron: Gutowsky. *Metallurgie*, V., 463 (1908). Phosphoric iron P 1.32. C 3.5 per cent. Si 2.05. Furnace arrangement. Freezing from 1225°. Eutectic 1128°, x_2 1095, x_1 944°, Ar_1 739° C. Binary phosphide eutectic melts at 980° C., freezes at 944° C. Graphite forms during the freezing of the cementite eutectic.

Nickeliferous and Manganiferous Cast-Irons: Leon Guillet. *Rev. de Met.*, V., 306. Alloys up to 48 per cent. Ni and to 44 per cent. Mn made. Metallography. Nickel facilitates the formation of graphite, manganese retards it. Nickel is in solution in the iron, manganese forms a double carbide.

Iron-Silicon-Carbon Alloys: Gontermann. *Zeits. anorg. Chem.*, 59, 1908, 373. The carbon-iron system. Two conjugate liquid solutions. The iron-silicon system. The ternary system.

Thermal and Metallographic Work on the Iron-Phosphorus System: E. Gercke. *Metallurgie*, V., 604. A series of alloys up to 9.55 per cent. P made. Iron holds up to 1.7 per cent. P in solution. Eutectic at 10 per cent. 980° C.

Contribution to the Study of Phosphoric Steels: De Kryloff. *Rev. de Met.*, V., 355. Steels with about 0.1 per cent. P, C .4 to .15 per cent. Mechanical tests. Metallography and heat treatment. A uniform structure may be obtained when Phos. is below 0.07 per cent. but above this heat treatment does not yield uniform ferrite and pearlite.

The Ternary System Iron-Phosphorus-Carbon: Goerens and Dobblestein. *Metallurgie*, V., 1908, 561. Ternary diagram. Ternary eutectic 1.96 per cent. C. 6.89 per cent. P. 91.15 per cent. Fe. 953° C. Freezing point curve. Microscopic. System is Fe_3C, Fe_3P and iron.

The Vanadium-Iron Alloys: Vogel and Tammann. *Zeits. anorg. Chem.*, 58, 1908, 73. Curve for Fe.V with 7.5 per cent. Si given. The V-Fe diagram shows a minimum at 31.5 per cent. V and 1435° G. Fe 1525°, V 1750° C. Mischkrystalle Fe + V.

Manganese and its Alloys with Carbon: A. Stadeler. *Metallurgie*,

V., 1908, 260, 281. Kryptol furnace. Freezing point 1207° C. Mn and Mn_3C form a series of solid solutions with a max. at 3.32 and per cent. C. at 1271° C. Break up into 2 conjugate solid solutions 0.75 3.6 per cent. C. at 866°–888° C. Metallography.

Note on the Structure of a Brittle Sheet of a Very Low Carbon Steel: A. Sauveur. *Electro-Chem. and Met. Ind.*, VI., 1908, 271. 0.05 per cent. C suffered from Stead's brittleness. Fracture on punching, at 45° to direction of rolling. Heated to 835° C. a sample showed thick parallel bands in the ferrite grains. May be due to strings of small crystals in the ferrite grain or to slip bands.

Hard Spots in Steel Castings with an Account of Certain Diffusion Phenomena: A. P. Scott. *Electro-Chem. and Met. Ind.*, VI., 1908, 281. Experiments to determine cause. Due to a lump of ferro failing to perfectly mix in the ladle and in form of molten globule reached the casting and there suffered considerable change. Practical and theoretical considerations.

The Hardness of Alloys and the Determination of Compounds: Kurnakow and Żemczużny. *Zeits. anorg. Chem.*, 60, 1908. 1. Iron alloys. Copper and zinc. Copper and tin. Copper and manganese. Copper and nickel. Gold and silver. Gold and copper, etc. Table of hardness of certain compounds and that of their components in Mohs' scale.

Optical Method of Determining Hardness of the Constituents of Alloys. Application to the Iron-Sulphur System: M. Ziegler. *Rev. de Met.*, V., 1908, 565. In Mohs' scale the hardness of the constituents corresponds to the measurements of the amount of polishing in relief as shown by microscope.

Application of the Brinell Test to Special Steels: L. Revillon. *Rev. de Met.*, V., 1908, 270. Formula. Graphic representation. P = 3,000 kgs. and ball of 10 mm.

The Hardness of Steels: Robin. *Rev. de Met.*, V., 1908, 893. Study and variations of hardness of metals by heat from the industrial standpoint. Brinell machine.

Rebound of a Ball: De Fréminville. *Rev. de Met.*, V., 329. Relation to hardness and elasticity of materials, with reference to Shore's sclerometer, *American Machinist*, Nov. 7, 1908. Discussion by *Maurer*, results of his apparatus, by Breuil, comparison with Brinell tests.

Determination of Nitrogen in Iron and Steel: A. S. de Osa. *Rev. de Met.*, V., 493. Method of Boussingault, *C. R.*, LIII., 5–10, 1861, is not precise enough for laboratory research.

Gas Occluded in Steels: G. Belloc. *Rev. de Met.*, V., 469. Investigation. Apparatus. Method of analysis. Tables and Curves. Critical points.

Gas Occluded in a Nickel Steel: G. Belloc. *Rev. de Met.*, V., 1908, 571. Amount of CO_2, CO, H and N. Temperatures up to 960° C.

Corrosion Tests on Iron and Steel: Ch. Fremont. *Rev. de Met.*, V., 1908, 649. Artistic application. Damascene. Industrial, historical.

Macroscopic examination. Solutions used. Method of photographing. Applications.

Experimental Research on the Thomas Processes: Wüst and Laval. *Metallurgie*, V., 1908, 431, 471. Converter. Analyses and curves for metal and slag. Metallography. Gases. Tables of heat production, etc.

A Bronze with Remarkable Properties: M. Escher. *Metallurgie*, V., 567. Parsons manganese bronze. Cu 58, Zn 38.5, Sn 1, Al 1, Fe 1, Mn 0.5.

The Electric Conductivity of Magnesium-Lead Alloys: N. J. Stefanow. *Zeits. anorg. Chem.*, 60, 1908, 209. References to previous work on conductivity of alloys. Curve determined for MgPb alloys, shows max. resistance at $PbMg_2$.

Analyses of English Pig Iron: Metallurgie, V., 1908, 689. Cleveland No. 1–3 and Forge. Cryesome. Whitwell, Thornaby. Thorncliffe. Cumberland and Lancashire. Scotch, etc. Ferro-silicon, silit co-spiegel, spiegel, etc. Cleveland ironstone, Bilbao hematite, Barrow, Scotch blackband, etc.

On the Constitution of Blast Furnace Slags: M. Theusner. *Metallurgie*, V., 1908, 657. Previous work. Slags from Bochumer Verein, Feutscher Hütte, Neunkirchen and Kratzwieck. Various solvents, citric acid, ammonium citrate, ammonium chloride. Melts of Al_2O_3, SiO_2 and CaO made. Microscopic examination.

Isomorphism of Calcium and Manganese Bisilicates: A. S. Ginsberg. *Zeits. anorg. Chem.*, 59, 1908, 346. $CaSiO_3$, 1512° C. and $MnSiO_3$ 1218° C. give a freezing point curve indicating a series of solid solutions with a minimum at 12.8 per cent. $CaSiO_3$ and 1184° C. Specific gravities mean of that of constituents, curve a straight line. Curve showing hardness indicates maximum about 20 per cent. $CaSiO_3$.

ABSTRACTS OF RECENT MINING DECISIONS.*

LOCATION OF CLAIMS.

PLACER MINING CLAIMS — EXCESSIVE AREA — RELOCATION.

The fact that a placer mining claim as staked exceeded the legal limit had the effect to render the claim void only as to the excess; and where the owner was in possession and working the claim in good faith, he had the right to elect what part he would relinquish as such excess within a reasonable time after he discovered such fact, and he could not be forced to surrender any particular part by the location thereon of an overlapping claim by another before he knew of such excess.

Zimmerman *v.* Funchion, 161 Fed. 859, May, 1908.

LOCATION AND POSSESSION OF MINING CLAIM — TEMPORARY SUSPENSION OF WORK.

Where locators after properly locating a mining claim and marking its boundaries, had sunk a shaft resulting in the discovery of mineral, a temporary suspension of the work for a few days for the purpose of procuring tools and necessary supplies for the continuation of the work, did not constitute a break in the actual possession sufficient to entitle another to enter upon and relocate any portion of the claim, although such entry was made before the locators had actually discovered mineral.

Hanson *v.* Craig, 161 Fed. 861, May, 1908.

CONFLICTING RIGHTS.

FORFEITURE OF MINING CLAIM — RELOCATION — BURDEN.

A person attempting to relocate a mining claim on the ground of forfeiture of the original location for failure to make the required improvements has the burden of establishing such forfeiture. This may be done prima facie, by proof that no labor was performed within the limits of the original claim during the required year. In a case where such prima facie case was made it was held that the burden then shifted to the original locator to show that work performed on an adjacent claim inured to the benefit of the controverted claim.

Fredericks *v.* Klauser, (Ore.) 96 Pacific 679, July, 1908.

MINING LEASES.

MINING LEASES — TRUST FUNDS — SET-OFF.

A lessor in a mining lease having in hand certain trust funds belonging to the lessee, as the proceeds of the sale of ore under the terms of the lease, cannot retain such funds in order that it may off-set against the same damages due for violations of the lease.

Florence-Goldfield Mining Co. *v.* District Court of First Judicial District of Nevada, (Nev.) 97 Pacific 49. (No date.)

* Prepared for the SCHOOL OF MINES QUARTERLY, by J. W. Thompson, Attorney-at-Law, Indianapolis, Indiana.

MINING LEASE — FUNDS IN LESSOR'S POSSESSION — DEPOSIT.

The lessee under a mining lease was to deliver all ore to the lessor, who should mill the same and pay to the lessee a certain per cent. of the smelter returns. In an action by the lessor against the lessee for damages for violating the terms of the lease, the lessor admitted the possession of the sum due the lessee. It was held that the lessor was the trustee for the lessee as to such sum, and he was therefore properly directed to pay the same into court.

Florence-Goldfield Mining Co. *v.* District Court of First Judicial District of Nevada, (Nev.) 97 Pacific 49. (No date.)

MINING LEASE — LIEN FOR ROYALTIES — FIXTURES.

A mining lease gave the lessor the first lien on all improvements to secure the payment of royalties on coal mined; giving also to the lessee the right to remove the building, machinery, etc., subject to the conditions of the lease. Under the lease it was held that the building, machinery, etc., were not fixtures, and the lessor had no interest therein except the lien for unpaid royalties.

Cherokee Construction Co. *v.* Bishop, (Ark.) 112 Southwestern 189, May, 1908.

LEASE OF COAL MINES — FORFEITURE.

A coal lease provided that the lessee should operate all mines with due diligence, and that no mine opened should remain idle for more than thirty consecutive days in any one year, unless caused by strikes or other unavoidable causes. A mine remaining unoperated for ten consecutive months in one year, and four months in another year, was sufficient ground for forfeiting the lease.

Cherokee Construction Co. *v.* Bishop, (Ark.) 112 Southwestern 189, May, 1908.

ASSESSMENT WORK.

MEANING OF "IMPROVEMENT" ON A MINING CLAIM.

The word "improvement" as used in the United States statute, requiring the making of certain annual improvements on a mining claim, was held to mean an artificial change of the physical conditions of the earth in, upon or so reasonably near, a mining claim, as to evidence a design to discover mineral therein or to facilitate its extraction, and in all cases the alteration must be reasonably permanent in character.

Fredericks *v.* Klauser, (Ore.) 96 Pacific 679, July, 1908.

IMPROVEMENTS ON CONTIGUOUS CLAIMS.

The United States statutes require the making of improvements on each mining claim each year, except where claims are held in common; in which case the improvements may be made on any one claim, but only where the claims are contiguous and held in common.

Fredericks *v.* Klauser, (Ore.) 96 Pacific 679, July, 1908.

IMPROVEMENTS ON ONE MINING CLAIM NO AID TO OTHERS.

The sum of $132 allowed for improvements on one mining claim made in a year was sufficient to prevent a forfeiture of such claim, but

would not prevent a forfeiture of other claims in a group, upon which no improvements were made.

Frederick *v.* Klauser, (Ore.) 96 Pacific 679, July, 1908.

IMPROVEMENT OF MINING CLAIM.

Materials taken to a mining claim with the intention of using them in making improvements cannot be considered in estimating the value of work actually done. The maxim that equity regards as done that which was intended, has no application to a positive statutory duty.

Fredericks *v.* Klauser, (Ore.) 96 Pacific 679, July, 1908.

WHAT MAY BE CONSIDERED AS IMPROVEMENT OF MINING CLAIMS.

The value of the following articles may be considered in estimating the value of improvements on a mining claim: Powder, fuse and candles; the reasonable value of meals furnished laborers employed in doing development work, who received board in addition to their wages; but not sums paid for transporting such supplies. The value of rails laid on ties in a tunnel, and a reasonable value of the use of tools, may be considered, but not the price paid for such tools. Nor do such items as cutlery, dishes, tinware, groceries, provisions, tobacco and bed clothing constitute improvements. The locator is entitled to a credit for the actual work of an employe though hired as a watchman, where no watchman was required.

Fredericks *v.* Klauser, (Ore.) 96 Pacific 679, July, 1908.

LIABILITY OF INJURY TO MINER.

NEGLIGENCE — FAILURE TO PROP ROOF OF MINE.

A mining company was held to be guilty of negligence for failure to properly support the roof of the mine, where it permitted a space between fifty and sixty feet square to remain without props for more than a month, and where its superintendent knew that the ash rock of which the roof was composed was liable to fall at any time when jarred by the blasts which were constantly being shot in the immediate vicinity.

Ianne *v.* United States Gypsum Co., 110 New York Supplement 496, May, 1908.

INJURY TO MINER — MINER MAKING MINE SAFE.

A carman in a gypsum mine, immediately prior to his injury had been ordered to remove from the foot of the shaft a load of props with which to support the mine roof, and such props were being unloaded and delivered to the prop setter when the carman was killed by the fall of a portion of the roof. Under these facts it was held that the carman was not engaged in making the mine safe at the time of his death, and having no knowledge of the danger attending the failure to properly prop the mine, the mining company was held liable for failing to afford him a reasonably safe place in which to work.

Ianne *v.* United States Gypsum Co., 110 New York Supplement 496, May, 1908.

BOOK REVIEWS.

Water Power Engineering: The Theory, Investigation and Development of Water Powers. By DANIEL W. MEAD, member A. S. C. E., Consulting Engineer, Professor of Hydraulic and Sanitary Engineering, University of Wisconson. New York, McGraw Publishing Co. Cloth, 8vo, pp. 787.

This book is a valuable contribution to available text-books on the subject, and is believed to be the most comprehensive treatment available in one volume for English-speaking students. It is well printed and includes over seven hundred and fifty pages and four hundred diagrams and cuts, all large and clear, and many useful tables. Some of its objects are well set forth in the preface, and which, by the way, is really related to the book. "In the development of a water power project an engineer is frequently called upon to do more than design and construct a power plant. He may be required to report on the adequacy of the supply, head and power available and the probable variations in the same; the the plan of development, cost of construction and operation and the advisability of the investment." "In the preparation of this book the author has endeavored to consider, briefly at least, all the fundamental principles and to point out the basis upon which successful water power development depends." From this it will appear that the book is concerned with water power development in all its engineering phases and not merely with water wheels, governors or any other detail of the development, such as dams, spillways, canals and pipe lines, but with all these as well as other things giving to each space in proportion to its importance and difficulty. No attempt has been made to destroy the rigor of the treatment by the elimination of mathematics or by trying to make topics which are really difficult seem easy. Whenever a subject is of such a nature as to permit of mathematical analysis it is so treated and free use of calculus is made throughout. The various chapter headings, of which there are twenty eight, in addition to some valuable appendices, indicate truly the scope of the work. Each chapter ends with at least a page and in some cases with several pages of references on the topics discussed in that chapter. These references are for the most part to individual papers that have appeared in technical journals and transactions and form the best bibliography on the subject in existence, at the same time calling attention indirectly to the fact that the best information on the subject is not to be found in the books. While the author has freely used other published material he has made consistent use of it, for the plan of treatment is distinctly his own and nothing has been copied into the text irrelevantly or without due credit. The chapter headings include: Historic Treatment, 18 pages; Review of the Principles of Hydraulics, 21 pages; Power of Streams by Hydrographs as Continuous Maximum Power Output Curves, 43 pages; Rainfall: Conditions of Variations, Use of Maps and Statis-

tics, 18 pages; Disposition of Rainfall with Conditions of Rate, Receiving Surface, Geology, Wind, Evaporation, Percolation, 22 pages; Run-off and Comparison with Rainfall and Effect on Stream Flow and its Relation to Storage, 42 pages; Stream Flow and Relation to Condition of Channels, Velocity at Various Points of Cross-Section, and Ice Covering, 23 pages; Measurement of Stream Flow and its Estimation, 20 pages; Types of Water Wheels with Special Reference to American Practice, 19 pages; Turbine Details and Structure, 37 pages; Hydraulics of the Turbine Involving Computation of Relation of Performance to Speeds, Heads, Diameters and Quantity of Water, 25 pages; Testing of Turbines, 45 pages; Conditions Involving the Selection of a Turbine for Given Conditions, 29 pages; Load Curves and Load Factors for Different Conditions of Plant Service and the Relation of Load Curves to Stream Flow and Auxiliary Power Requirements, 36 pages; Turbine Speed Regulation, Including Governors, Acceleration of Penstock Water, Water Hammer, Limiting Rate of Gate Movement, Flywheels, Stand Pipe, Air Chambers, being considered as regulation auxiliaries, 20 pages; The Water Wheel Governor as a Machine, Including Switchboard Control Systems, 30 pages; Installation of the Reaction Wheel, 30 pages; General Selection of Machinery in Plant Design, Including Effect of Sizes of Units on Cost, Overload, Econ›my of Operation and Other Details, 25 pages; Typical Examples of Water Power Installations, 12 pages; Relation of Dam and Power Station, 24 pages; Principles of Dam Construction, Including Movable Dams, Gates, Gate Hoists, 42 pages; Pondage and Storage, the Relation of Pondage to Power Limits, and Auxiliary Power, 21 pages; Cost of Water Power, its Value and Sale, the Value of the Water Power Property, 22 pages; Investigation of Water Power Projects Including a General Method of Investigation with an Ideal Form of Report on the Project, 29 pages.

This book is a fine illustration of the fact that so many recent developments in engineering do not logically fall within the province of any one of the divisions of mining, electrical, civil, mechanical, so often adopted in our schools and more or less following the organization of National Engineering Societies. The modern water power development problem includes work that is ordinarily considered the function of the civil engineer, mechanical engineer and the electrical engineer. This book gives equally fair treatment to the three parts of the work in one unit and while the mechanical engineer might desire a different sort of treatment of turbine wheels or governors, and the electrical engineer of the problems of electrical generation and distribution, and the civil engineer of his part of the work, yet as a whole the balance attained is quite good. For the engineering student the book may seem a little too full and yet it must be clearly kept in mind that there is too often a tendency in some of our courses of instruction to give students an idea that they have learned the subject when they have scarcely more than acquired the use of special terms. It is a far better practice in dealing with a subject of this importance in engineering classes to use portions of a full book to meet the time limit requirement than to use a book exactly fitting the needs of the course. This practice will give the students a fairly good idea of what part of the subject they have cov-

ered, while at the same time it makes it clear that there is much of the subject still untouched.

The author of this book is to be congratulated on having produced a serious piece of work, quite different in character from the ordinary American text-book, and in conclusion the reviewer offers his congratulations to Professor Mead even though he is not in sympathy with the title of "Water Power Engineering," which seems to suggest still another class of engineering at a time when we already have too many and would suggest the addition of numerous problems.

C. E. L.

A Manual of Underground Surveying. By LOYAL WINGATE TRUMBULL, E.M., Consulting Mining Engineer; formerly Professor of Mining, University of Wyoming; formerly United States Deputy Mineral Surveyor for Colorado. New York, Hill Publishing Company, 1908. Pp. x + 250. Illustrated. $3.00 net.

Table of Contents (condensed): *Instruments* — Transit, adjustments, attachments, special transits, tapes. *Meridian* — Polaris, direct solar observation, geographical solution. *Underground Practice* — Stations: Marking, numbering, setting up transit, sighting in dark. *Carrying the Meridian Underground* — Wires and weights, three-wire and four-wire methods, bent line method, vertical sights. *Survey of Secondary Openings* — Coal mines, narrow stopes, stope-hooks, string surveys, estimates of value and volume. *Record of the Survey* — Field notes, note-books, side notes, office books, calculation-book. *Uses of Mine Maps* — Laws regarding mine maps, topographical maps, geological maps and sections, old workings, assay maps. *Making the Map.* Platting of angles, use of protractor, coördinates. *Map Filing* — Ink and colors, blueprints, Vandyke prints, copying drawings. *Bore-Hole Surveys* — Photographic surveying. *Methods of Engineers* at different mines. United States Deputy Mineral Surveyor's Examination, with a list of problems.

Among the best parts of this book are those dealing with the adjustments of the transit; correction of errors, such as the deviation of the vertical axis of the instrument from the true vertical, axial errors in relation to the measurement of angles, errors of eccentricity of the telescope, graduated circle and verniers; the explanations of the use of top and side telescopes; together with the methods of taking observations for the establishment of the meridian (the latter section being reprinted from "Mineral Land Surveying" by James Underhill). These subjects are clearly presented, with sufficient detail for the use of anyone acquainted with the rudiments of field surveying.

Some of the other chapters are not so satisfactory: for example, underground practice is given with a brevity that presupposes considerable knowledge of the subject, and the modes of dealing with the practical difficulties of plumbing deep shafts for carrying the meridian underground are dealt with in hardly enough detail. The same is true of "Bore-hole Surveying," which, notwithstanding its importance in these days of extensive diamond-drill boring operations, is discussed in only three pages. The forms of field notes and tabulation of calculated results are insufficiently set forth. It may be pointed out that such

subjects as these are of much greater moment to the surveyor than the resumé of the history of transits, which occupies over ten pages of Chapter I.

To illustrate the "Uses of Mine Maps," a number of abstracts of papers and monographs have been collected, which constitute a fair presentment of the subject. In the brief chapter on "The Making of Mine Maps," the author might have gone further in pointing out some of the difficulties that may be encountered in delineating satisfactorily very irregular workings of the chamber form and the levels and stopes of veins with large variation in strike or dip.

The long Chapter XI., containing descriptions of the surveying methods and practice of different engineers, is useful. We think, however, that these data would have served their purpose better had they been inserted in the earlier part of the book, in connection with the subjects to which they severally relate. Thus, while the "Method of Keeping Stope-Books" is mentioned under its heading on page 120, Chapter VI., the subject itself, with the illustrations, is really given in several parts of Chapter XI. This remark applies also to the shaft-surveying notes in the same chapter. A partial bibliography follows each chapter, and the index and illustrations are in general good.

While making the above criticisms we do not lose sight of the good points of the book, some of which have been noted specifically. The writing of a thoroughly satisfactory book on any technical subject is a difficult task. In this case the criticisms related not to error so much as to matters of arrangement and to omissions which doubtless had their origin in the author's desire to be concise. To the publisher we would suggest that the paper might have been thinner, thereby making the book lighter and more convenient for field use.

R. P.

The Miner's Pocket-Book: a reference book for engineers and others engaged in metalliferous mining. By C. G. WARNFORD-LOCK, M.Inst.M.M., F.G.S. Fifth edition, entirely rewritten. London, E. & F. N. Spon, Ltd.; New York, Spon & Chamberlain, 1908. Pp. viii + 624. $4.00 net.

This new edition of the well-known "Miners' Pocket-Book" has undergone change in many respects. As stated in the preface, "the deletion of matter possessing but limited interest has made room for a material expansion of the more important subjects connected with underground operation" of mines. The author has done much to bring up to date a book that has long been of service to the mining profession.

Under the head of new matter are references to recent developments in the compression of air by the direct action of falling water; additions to the sections on gas-power plant, rope-driving, electric transmission, prospecting with diamond drill and other boring appliances; also, rock-drills and their work, with speeds and costs. The chapter on shaft-sinking has been enlarged and improved by abstracts from a number of the recent papers on the subject, appearing in the transactions of mining societies and technical journals. It may be pointed out, however, that the author has omitted to refer, except in the briefest

way, to the important improvements which have been made, especially in Germany, during the past few years in the methods of sinking in loose, water-bearing soils. Also, under the heads of development and mining methods, the subject of timbering is not yet adequately treated, particularly in the matter of illustrations.

The methods of surface mining and dredging are given with considerable fullness. New data are inserted under "Centrifugal Pumps," "Mining Methods," and "Mining Costs." Underground haulage and hoisting are well outlined, though we think more attention should be given to the subject of electric-driven hoisting engines.

In conclusion, though we have ventured to take exception to the author's mode of treatment of some parts of the extensive subject dealt with, we commend highly this new edition of a hand-book which had already attained a recognized place among mining publications.

R. P.

Cyanide Processes. By E. B. WILSON, E.M. John Wiley and Sons. Fourth Edition. 12mo, vii + 249 p. 26 figs. Cloth $1.50.

The book is divided into seventeen chapters treating the following subjects: Ores suitable for Cyanide Processes. Potassium Cyanide and Oxygen. Chemistry of the Process. Laboratory tests. Plants for Cyaniding. Leaching the ore. Precipitating gold from Cyanide Solutions. Treatment of Bullion. Treatment of Concentrates and Slimes. Electricity applied to Cyaniding. Electrodes. The Current. Anodes. Cathodes. Siemens-Halske and Pelatan-Clerici Processes. Cyaniding Slimes. General information. Appendix; Instructions how to proceed with the treatment of a case of cyanide poisoning in the absence of Medical Assistance. Index.

In the preface the author points out that he has taken up the first principles and discussed those matters which have an actual bearing on the subject, and has not attempted to incorporate the mass of facts, fancies and details that have been advanced concerning cyaniding. The details of plant construction have been omitted because they vary at each mill and belong to the engineer and mill supply company.

The most important addition is the chapter on the Treatment of Slime: —Separation of Sand and Slime. Butters-Blaisdell equipment. Slime agitators, Blaisdell, Hendrix. Slime decantation process. Filter-press process. Sweetland press described. Vacuum filter. Moore's Slime process, movable type. Butters' process, stationary type. Blaisdell pressure filter. Kelly pressure filter. The Adair-Usher Slime process. Nichols slime-settling process.

The book fulfils its purpose in treating in a clear and concise manner the principles of the subject. The illustrations in line are good but the half-tone figs. 13, 24, and 25 are indistinct. The value of the book, however, could be greatly increased for more than one class of readers by the addition of selected references on the main topics discussed, without increasing the size materially. Printing, paper and binding are good.

W. C.

Gold and Silver. By W. R. CRANE, Ph. D. John Wiley and Sons. 8vo, x+ 727 pages, illustrated. Cloth, $5.00.

As one of the volumes of the Economic History of the United States prepared under the auspices of the Carnegie Institution of Washington, this work embraces a wide field as a glance at the table of contents will show: Chapter I. Precious Metal Mining — a Factor in the Industrial Growth of the United States, 19 pages. Chapter II. An Historical Account of the Discovery of Gold and Silver, 131 pages on First Discoveries and Legends, Early History, Recent History by States and Territories, Chronology of Gold and Silver Mining in the United States. Chapter III. Occurrence and Association of Gold and Silver, 178 pages dealing with the Theory of Ore Formation and Occurrence of Gold in Gravel, Occurrence in Veins by States and Territories, Permanence in Depth, Occurrence of Gold in Gravels by States and Territories. Chapter IV. Geological Distribution of Gold and Silver, 11 pages. Chapter V. Mining Gold and Silver Ores and Gravels, 130 pages embracing an Historical Sketch of the Development of Mining Industry, Description of Methods of Mining, Gravel, Ore Mining in Narrow Veins, Wide Veins, Beds and Masses. Chapter VI. Extraction of Values, 83 pages, Historical Sketch, Methods of Extraction, Milling. Metallurgy — Pyritic Smelting, Chlorination and Cyanide Processes. Chapter VII. Production of Gold and Silver, 99 pages, Introduction, Production of the United States, of the World, by States and Territories. There are six tables in the appendix giving the Discovery of Gold and Silver Mines and Districts, Occurrence and Mineralogical Association of Gold and Silver, Geological Distribution of Gold and Silver, Yield of Ores by Districts and Mines, Yield of Gravels by Districts and Mines, Fineness and Value of Gold and Silver. Bibliography and index of 7 pages.

The book contains a mass of very readable information of great interest especially to those interested in mining. It is well written and put together and will undoubtedly prove a valuable acquisition and addition to the literature of gold and silver mining and production in the United States. One quotation (p. 16) through the omission of the word *not* from the original is rather startling. "But let us conceal from ourselves the fact that mere growth in wealth, mere development in industry, mere increase in population are not the best evidences of national greatness."

W. C.

Laboratory Experiments in Metallurgy. By ALBERT SAUVEUR and H. M. BOYLSTON. Published by the authors, Cambridge, Mass. 1908. $1.25.

Short notes written primarily for the use of students at Harvard University who take the courses in general metallurgy and in the metallurgy of iron and steel.

The book consists of two parts. The first on general metallurgy contains thirteen experiments as follows: Coking and proximate analysis of coal. Calorimetry, the Parr calorimeter. Pyrometry, the Siemen's water pyrometer, the Mesuré and Nouel optical pyrometer, the

Le Chatelier thermo-electric pyrometer, the melting points of tin, lead and zinc. Reduction of copper oxide by carbon, of lead oxide by carbon, of iron oxide by metallic aluminium, the Thermit reaction. Reduction of copper oxide by copper sulphide, of lead oxide by lead sulphide.

Part two contains thirteen experiments in iron and steel, nine of which necessitate the use of a testing machine for tensile strength, etc., or for hardness by Brinell's method. They are: Influence of carbon upon the tenacity, elasticity and ductility of iron, the influence of nickel on the same. The thermal critical points of steel. The changes in magnetic properties occurring at the thermal critical points. Relation between the critical points and the hardening power of steel; also the brittleness produced by hardening. The hardness produced in high carbon steel by sudden cooling (quenching) from a high temperature. Influence of hardening upon the ductility, elasticity and transverse strength of steel. Influence of carbon upon (1) the hardness (2) the hardening power of steel. Influence of the nature of the quenching bath upon the hardening of steel. Tempering of hardened steel. Influence of certain heat treatments upon the physical properties of steel. Effect of annealing upon the properties of cold worked steel. Effect of heat upon the grain of steel. In the text there are several tables such as typical analyses of various coals; corrections for decrease in weight of iron and copper cylinders of the Siemen's water pyrometer; temperature tables for use with the Mesuré and Nouel pyrometer; melting points of metals; thermochemical data, etc.

To each experiment is attached the requisite laboratory report to be filled in by the student, with necessary conclusions or remarks.

The choice of experiments has been carefully made to teach the student many of the fundamental principles underlying metallurgical work and, in the section on iron and steel, to emphasize the influence of carbon on the physical properties and the relation of the critical points to the hardening power of steel. The directions are given very clearly and the work demands thought on the part of the student as well as the mere performance.

The book will serve as a basis for a short course but is laid out on such broad lines that the work may easily be expanded at will. For example in part one optical and other pyrometers (Wanner and Féry) may be compared with the Le Chatelier thermo-electric; other metals such as aluminium, antimony and copper or various alloys may be added; and the calibration of the thermo-electric pyrometer may be taught. In part two other kinds of steel may be added and by addition of metallographic examination of the specimens used, structure could be contrasted with treatment composition and physical properties.

The book treats a subject of increasing importance in the right way and the authors have produced the kind of book for which there is a growing demand.

W. C.

Laboratory Exercises in Physical Chemistry. By FREDERICK H. GETMAN. Second edition, revised. New York, John Wiley & Sons, 1908. 12mo, pp. x + 285 and 115 figures. $2.00 net.

In this edition, besides inserting a chapter on thermostats, and giving a brief outline of the methods employed for the measurement of radioactivity, the author has enlarged and bought up to date many of the subjects treated in the first edition. The book is to be recommended very highly as a manual for undergraduate laboratory work in physical chemistry.

J. LIVINGSTON R. MORGAN.

Earth Slopes, Retaining Walls and Dams. By CHARLES PRELINI, C.E., Professor of Civil Engineering, Manhattan College, New York City. Author of "Earth and Rock Excavation," "Tunnelling," etc. New York, D. Van Nostrand. $2.00 net.

The author of the above work, which consists of 130 pages of printed matter together with 75 line cuts, is known to the engineering profession through his previous treatises on "Earth and Rock Excavation" and "Tunnelling."

This most recent volume is divided into five chapters, which, as stated in the short but excellent preface, handle the subject as follows: "In the first chapter attention is given to the forces which determine the various slopes of earth embankment.

"The second is devoted to the graphical determination of the pressure of earth against a retaining wall, following the theory of Professor Rebhaun, . . . and also contains solutions of the different problems which may be encountered in practical work.

"In the third is given the analytical demonstration of Professor Rebhaun's theory, together with the formulas deduced from the analytical theories of Weyrauch and Rankine.

"The fourth is devoted to the design of retaining walls, . . . and the fifth to the design of dams."

The preface also states that the text has been prepared for students, not professional engineers, and, while it might seem at first glance that material intended for the one is necessarily suited to the other, the author's experience both as a teacher and a writer of engineering texts, must be accepted as the guide in this regard. The only questions that may arise therefore, are whether there has been a judicious selection of material and whether it has received proper treatment. The latter may be commended, but it is doubtful if the subject has been presented upon the broad lines which should characterize engineering texts.

Specifically, the last chapter may be criticized for failing to devote more space to the design of high masonary dams. At the present time, practice generally requires studies to be made after the method of Wegmann in the determination of the stability of a high masonary dam, but the text neither mentions this, nor does it give directions to be followed, if the profile of such a structure is desired.

There are a few typographical errors such as those appearing on pages 36, and 114, which, while not serious, should have been corrected in

the proof. An index would have added considerably to the value of the book.

In spite of these drawbacks, however, there are elements in the presentation, which makes it a desirable text for certain classes of students.

C. E. M.

Electrical Illuminating Engineering. By WILLIAM E. BARROWS, Jr., B.S., E.E., Assistant Professor of Electrical Engineering, Armour Institute of Technology. New York, McGraw Publishing Co., 1908. 12mo, pp. v + 216. $2.00 net.

This book is divided into 11 sections as follows: (1) Light and Color, (2) Units of Illumination and Photometry, (3) Photometry and Photometers, (4) Spherical Photometry and Integrating Photometers, (5) Standards of Illuminating Power, (6) Incandescent Lamps, (7) Arc Lamps, (8) Flaming Arc Lamps, (9) Vapor Lamps, (10) Shades and Reflectors, (11) Illumination Calculations.

The work is presented in an admirably systematic manner and contains considerable information of real technical value. In fact the book is an excellent reference on the various methods of Electrical Illumination. The section on "Illuminating Calculation" is very interesting and contains curves and tables of value. This work is well worthy of a place in the library of the technical man and can be recommended to the students as an excellent reference book. M. A.

Electric Motors. Their Installation, Control, Operation and Maintenance. By NORMAN G. MEAD. New York, McGraw Publishing Co., 1908. 16mo, pp. v + 159, 126 illustrations. $1.00 net.

The title of this book is altogether too ambitious. To properly cover the broad field indicated by the title would require a work of many hundred pages and in consequence thereof the matter presented in the 159 pages in this book is so very general in its character as to be of little value.

The book is of no worth to the technical man; it might be interesting reading for the layman. M. A.

Coal. By JAMES TONGE. New York, D. Van Nostrand Company 1907. Small 8vo, cloth, pp. vii + 275. Price $2.00 net.

The book is divided into fifteen chapters as follows: History, Occurrence, Mode of Formation of Coal Seams, Fossils of the Coal Measures, Botany of the Coal Measure Plants, Coalfields of the British Isles, Foreign Coalfields, The Classification of Coals, The Valuation of Coal, Foreign Coals and their Values, Uses of Coal, The Production of Heat from Coal, Waste of Coal, The Preparation of Coal for the Market, Coaling Stations of the World.

The author is Lecturer on Mining at the Victoria University, Manchester, and writes from a rather strictly British point of view. Having published a more technical work on the "Principles and Practice of Coal Mining," he does not here attempt to present the detailed data required by an engineer or chemist but rather addresses those having only a more general interest in the subject. To the needs of such

readers the book appears to be well adapted. It treats the subject broadly, is clearly and interestingly written, well illustrated, and excellently printed and bound. H. C. S.

The Journal of Industrial and Engineering Chemistry. Published by the American Chemical Society, Editorial Office, 4306 Forrestville Ave., Chicago. Monthly, quarto, $6.00 per year.

This new journal devoted to industrial chemistry and chemical engineering is owned and published by the American Chemical Society and sent to all its members. It is edited by Wm. D. Richardson, with the coöperation of the following associate editors: Geo. P. Adamson, E. G. Bailey, G. E. Barton, Wm. Campbell, F. B. Carpenter, Virgil Coblentz, Francis I. Dupont, W. C. Ebaugh, Wm. C. Geer, W. F. Hillebrand, W. D. Horne, L. P. Kinnicutt, A. E. Leach, F. W. Lovejoy, Karl Langenbeck, A. D. Little, P. C. McIlhiney, E. B. McCready, J. Merritt Mathews, T. J. Parker, J. D. Pennock, Clifford Richardson, Geo. C. Stone, F. W. Traphagen, F. H. Thorp, Ernest Twitchell, Robert Wahl, Wm. H. Walker, M. C. Whitaker, W. R. Whitney. With a Board of Editors composed of members prominent in such varied lines of activity there can be little doubt that all branches of applied chemistry will be represented in the pages of this new journal. The first issue contains 5 quarto pages of signed editorials on the purpose of the journal, the ethics of engineering supplies, the sugar industry, the fixation of nitrogen, and on standard methods of analysis; 35 pages of original articles on Portland cement, anthracite producer practise, physical properties of mixed lubricating oils, a new bomb calorimeter, manufacture of oil of lemon and citrate of lime in Sicily, turpentine and its adulterants, wine analysis, and testing of milk for evidence of added water; 20 pages of notes, quotations, book reviews, book list, news of scientific societies, trade and industrial notes, regulations and rulings of the Government departments, of the courts and the Customs Service.

This journal bids fair to supply a want which has been felt for some time in this country, and which could be only partly filled by foreign publications. It will be valuable not only to professional chemists, but to many other technical men as well. Most of those who wish the *Journal of Industrial and Engineering Chemistry* will doubtless prefer to obtain it by joining the American Chemical Society, whose membership, open to all who are interested in chemistry or any of its applications, has now grown to over 4,000. Each member receives monthly from the Society the *Journal of the American Chemical Society*, the *Journal of Industrial and Engineering Chemistry*, and two numbers of its semimonthly *Chemical Abstracts*.

The remarkable growth and development of the American Chemical Society and its journals, especially during the past two years, under the presidency of Professor Bogert, has resulted in providing for suitable publication of American work in any of the branches or applications of chemistry, and at the same time has rendered American chemists and technologists practically independent of foreign publications, so far as concerns the news of the chemical industries and abstracts of the current literature of chemistry and chemical engineering.

H. C. S.

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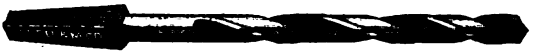

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THE ELECTRON CONCEPTION OF VALENCY IN ORGANIC CHEMISTRY.

BY J. M. NELSON AND K. GEORGE FALK.

Received February 8, 1909.

In his address before the American Chemical Society, delivered in 1902, on the "Life History of a Doctrine" * in reviewing the development of the theory of valency, President Ira Remsen made the following statement: "The latest turn that has been given to the conception of the atom brings in again the electric charge. It appears that the cotemporaries of Berzelius were too easily frightened and Berzelius was nearer right than they supposed. Every book on the history of chemistry has an obituary on the electrochemical theory of Berzelius. But now it appears that the electric charges assumed by him must be assumed by us. These have come more and more to the front of late, and chemical union is being regarded more and more as due to the interaction of these charges."

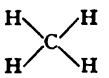
Berzelius based his electrochemical theory upon the hypothesis that electric polarity was a property of the atoms of substances, and by virtue of the opposite polarities of these atoms that they combined. This theory accounted satisfactorily for inorganic compounds, but apparently broke down when attempts were made to include organic compounds, and the principle of substitution, which led later to the unitary theory. The great development of

* Published in *Journ. Am. Chem. Soc.*, *25*, 131 (1903).

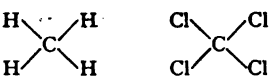
organic chemistry threw the electrical theories of combination into the background for a number of years, but recently this question has been approached again from an entirely new standpoint which promises to include the older as well as the newer theories of combination.

J. J. Thomson in "The Corpuscular Theory of Matter" * in the chapter on "The Arrangement of Corpuscles in the Atom," after discussing various stable systems of corpuscles and comparing them with the valency of elements as shown in the periodic system, develops the ideas of forces between atoms and chemical combination from this point of view. The following paragraph † states the conception which it is desired to elaborate in this article:

"On the view of chemical combination given above, the valency of an element depends upon the number of corpuscles which can be transferred to or from an atom of the element by the action of atoms of other elements. For each valency bond established between two atoms the transference of one corpuscle from the one atom to the other has taken place, the atom receiving the corpuscle acquiring a unit charge of negative electricity, the other by the loss of the corpuscle acquiring a unit charge of positive. This electrical process may be represented by the production of a unit tube of electric force between the two atoms, the tube starting from the positive and ending on the negative atom. In this way we can give a physical interpretation to the lines by which in graphical formulæ the chemists represent the valency bonds, these lines representing the tubes of force which stretch between the atoms connected by the bond. Thus, for example, the lines in the graphical formula



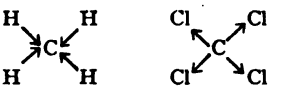
represent the tubes of electric force which stretch between the carbon atom and the four hydrogen atoms. There is, however, one important difference between the lines representing the bonds and the tubes of electric force. The lines used by the chemist are not supposed to have direction. Thus in the two compounds



* Published in 1907.

† Pp. 138–139.

the lines joining the carbon atom to the hydrogen atoms are not distinguished in any way from those joining the carbon to the chlorine atoms. On the electrical theory, however, the tubes of electric force are regarded as having direction starting from the positive and ending on the negative atom; thus, if the hydrogen atoms are positively electrified in marsh gas, and the chlorine atoms negatively electrified in carbon tetrachloride, the graphical formulæ representing them would be

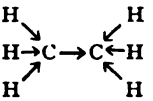


respectively, indicating that the carbon atom is not in the same condition in the two compounds as in one case it is the terminus, in the other the origin of the tubes of electric force."

The idea which J. J. Thomson proposes is, then, that when two atoms combine, a corpuscle is transferred from one atom to the other, resulting in the atom receiving the corpuscle becoming negatively, the other positively charged. The corpuscle in passing to the second atom does not, however, become entirely separated from the first, there remaining some connection between the two which may be imagined as lines of force holding the two atoms in chemical combination and therefore determining the chemical affinity. This is evidently the same state which is pictured as bonds or linkages in structural formulæ, with the addition, however, as J. J. Thomson points out, that the introduction of the electron conception requires the bond to have direction, or that *valency is a vector instead of a scalar quantity*. The use of this conception would not modify the structural formulæ employed at present, but would simply add to them, an arrow being used instead of a dash to denote a bond, the direction of the arrow showing the direction in which the corpuscle is transferred. Hydrochloric acid, $H \rightarrow Cl$ would then be different from the compound $H \leftarrow Cl$, if the latter were capable of existence. By using certain simplifying assumptions, J. J. Thomson calculated the numbers of corpuscles forming stable systems and showed analogies of these systems to the chemical elements when arranged in groups or series. These will not be used here, but the remainder of this paper will be devoted to an attempt to follow the introduction of the vector idea of valency into a number of compounds.

Considering carbon as having a valency varying between four positive and four negative, or in other words, capable of taking up or giving off four corpuscles, CH_4 and CCl_4 would be the two extreme types showing a difference in the carbon atom of eight corpuscles or of eight units of valency. The question of the direction of the valence when two atoms combine cannot be settled offhand. It seems fair to assume (for some assumption must be made or the whole subject will develop into drawing a large number of geometrical figures of which only very few represent actual compounds) that the direction of the valency between two atoms, when these are united by a single bond, will be fixed (as with hydrochloric acid H→Cl and not H←Cl), and that in possible isomers which may be formed as the result of some peculiar or exceptional reaction, one form will be very much more stable than the other. The direction of valency for those substances which are dissociated into ions in solution is readily ascertained, for other substances a study of the reactions will aid in throwing light upon the question.

In taking up the compounds of carbon containing single bonds, the introduction of directive valency will not do much in the way of clearing up doubtful points since the chemistry of these compounds is worked out fairly completely and satisfactorily without. It may be of interest, however, to call attention to some points. In methane, the four valencies are directed toward the carbon atom. In ethane, as J. J. Thomson * points out, the conditions may be represented by the formula



or one of the carbon atoms will have a charge of four units of negative electricity and the other of two units, or comparing the two methyl groups, one will be negatively charged, the other positively. With ethane there is no evidence of such a condition existing, but substituting the six hydrogen atoms by phenyl groups, hexaphenyl ethane would be obtained. If Gomberg's triphenyl methyl is assumed to be hexaphenyl ethane, then the two triphenyl methyl groups composing it would be charged differently, and it is an interesting fact that solutions of the sub-

* *Loc. cit.*, p. 131.

stance conduct the electric current,* and that Gomberg almost from the start explained this by the existence of the "pseudoions" $(C_6H_5)_3^+C$ and $(C_6H_5)_3^-C$.

In the solid state, then, hexaphenylethane, colorless, would be present; in solution, the colored ions exist, and are more reactive than the unionized organic compound, as is the case in general. The same is true of the triphenyl methyl halogen derivatives. The objection to this view of "triphenylmethyl" is, of course, that no atom or group of atoms is known with certainty capable of carrying both a positive and a negative charge.

The saturated dicarboxylic acids may also be taken up briefly. In malonic acid the arrangement of the groups may be represented by $(CO_2H)\leftarrow CH_2\rightarrow(CO_2H)$, or the molecule is symmetrical. In succinic acid, the arrangement would be $(CO_2HCH_2)\leftarrow(CH_2CO_2H)$, or unsymmetrical; in glutaric acid, $(CO_2HCH_2)\leftarrow CH_2\rightarrow(CH_2CO_2H)$, or symmetrical; in adipic acid, $(CO_2HCH_2CH_2)\leftarrow(CH_2CH_2CO_2H)$, or unsymmetrical; in pimelic acid, symmetrical again, and so on. These acids would therefore fall into two groups — those with an even number of carbon atoms or unsymmetrical, and those with an uneven number of carbon atoms or symmetrical, and the acids of each group should be comparable only with the acids of the same group, leaving out of account reactions which depend only upon the typical properties of the carboxyl and methylene groups. The fact that the saturated dibasic acids differ in properties depending upon whether an even or an uneven number of carbon atoms is present is a well-known one and is spoken of in all text-books of organic chemistry. The acids containing an even number of carbon atoms have higher melting points and are less soluble than the acids with an uneven number of carbon atoms immediately preceding and succeeding them, but show regularities when compared with the next acids with an even number of carbon atoms. The relations here when directive valencies are taken into account are perfectly clear and simple. It is probable that similar relations hold with the saturated monobasic acids, but the direction of the valencies cannot be shown as yet with sufficient certainty in their cases.

In taking up compounds of carbon containing a double bond,

* *Ber.*, *35*, 2397; Walden, *Z. physik. Chem.*, *43*, 451.

it is not possible to make any simple assumption regarding the direction of the valency when two groups combine, as was done with the singly bonded substances. It will be necessary to consider all the possible cases and from a study of the reactions decide which formula may be assigned to the various compounds.

The compounds containing a double bond may in general be divided into two classes: I. Compounds in which the two halves of the molecule are similar; and II. Compounds in which the two halves of the molecule are dissimilar. To the first class belong the substances of the general types $CR_2:CR_2$ and $CRR':CRR'$. Introducing the conception of directive valency, it is evident that there are possibilities of the existence of two isomers in each case; that is, the two valencies (or corpuscles) may proceed from one carbon atom to the other, or one may proceed in one direction and one in the other; or formulated as follows: $CR_2 \rightleftarrows CR_2$ and $CR_2 \rightrightarrows CR_2$; $CRR' \rightleftarrows CRR'$ and $CRR' \rightrightarrows CRR'$. If two isomers exist in any case, one would be expected to be more stable than the other; if only one substance of the general type exists, then it may be that the other is too unstable to be formed permanently, going over into the stable form, and it would be a question then, to determine by means of the chemical reactions of the substance, to which of the two types its reactions show it to conform best.

Of substances derived from the type $CR_2:CR_2$ very few,* perhaps none, are known to exist in two forms. The direction of the valencies in these compounds may be determined by following some of the addition reactions of closely related compounds. Since the molecule is perfectly symmetrical, it makes no difference in the resulting compound, in which way another substance, HI for instance, is added. If, however, as a typical example, propylene $CH_3 \cdot CH:CH_2$ is taken, the possibilities (the methyl group being a constant factor) would be $MeCH \rightleftarrows CH_2$ and $MeCH \rightrightarrows CH_2$ or $MeCH \leftrightarrows CH_2$ (three in the special case chosen). On treating with HI, if either of the last two represents the structural formula, the I would all go to one carbon atom, and the H to the other, only one substance being formed, while if the first represents the structure, a mixture of two substances should be formed, the H

* There are indications which appear to show that tetraphenyl ethylene exists in two forms.

and I being divided between the two carbon atoms. The reactions in this case might be represented as follows:

$$\begin{matrix} \mathrm{MeCH} \\ \mathrm{H \rightarrow I} \end{matrix} \rightleftarrows \mathrm{CH_2} = \mathrm{MeCH_2 \rightarrow CH_2I}$$

$$\begin{matrix} \mathrm{I \leftarrow H} \\ \mathrm{MeCH} \end{matrix} \rightleftarrows \mathrm{CH_2} = \mathrm{MeCHI \leftarrow CH_3}$$

The extent to which each of the products would be formed depends upon the influence of the methyl group as compared with the hydrogen or the double bond, and upon the difference in polarity between the hydrogen and iodine, the smaller the difference the more nearly equal would be the amounts of the two products formed. The following results were obtained by A. Michael:*

Propylene + HI formed principally $(CH_3)_2CHI$ together with a little $C_2H_5CH_2I$.

Propylene + ClBr yielded 5 parts $CH_3 \cdot CHBr \cdot CH_2Cl$ to 7 parts $CH_3 \cdot CHCl \cdot CH_2Br$.

Propylene + ClI yielded 1 part $CH_3 \cdot CHI \cdot CH_2Cl$ to 4 parts $CH_3 \cdot CHCl \cdot CH_2I$.

Propylene + HOCl formed principally $CH_3 \cdot CHOH \cdot CH_2Cl$ and perhaps a little $CH_3 \cdot CHCl \cdot CH_2OH$.

These examples have been quoted in order to throw some light, if possible, upon the direction of the valencies in unsaturated compounds existing in one form, and they indicate that this form has the structure $CR_2 \rightleftarrows CR_2$. Propylene does not belong to this type of compound, but it seems fair to carry over the conclusions arrived at with propylene to the symmetrical compounds and to assign this structure to the substance, if only one form exists, and if two forms exist, to assign to the more stable of the two this structure.

Of substances derived from the type CRR′ : CRR′ a large number of isomers are known, of which maleic and fumaric acids may serve as examples. The two forms of this type using the directive valencies are $CRR' \rightleftarrows CRR'$ and $CRR' \rightrightarrows CRR'$ of which the former represents the more stable, the latter the more unstable form. These two groups of substances belong to the fumaroid and maleinoid types, the fumaroid being the more stable, showing the higher melting points, less solubility and volatility, smaller

* *J. pr. Chem.*, 60, 286–384, 409–86 (1899).

heats of combustion, less color (if any is shown by either isomer), and in the case of acids, being weaker, than the maleinoid, all these properties being only different expressions for the difference in stability between the two forms. It will hardly be necessary to enter into a detailed description of the different substances included in this class. The possibility of addition would be worked out in each case in the same way indicated with propylene.

With the substances containing a double bond in which the two halves of the molecule are dissimilar, there are a greater number of possibilities, namely: $CR_2:CRR'$; $CR_2:CR_2'$; $CR_2:CR'R''$; $CRR':CR'R''$; $CRR':CR''R'''$. In each of these cases, using directive valencies, there would be three isomers possible; one valency acting in each direction, both valencies acting in one direction and both in the opposite direction. The substances corresponding to these types belong in general to the fumaroid and maleinoid types, but there is one striking and well-known substance which exists in three forms; cinnamic acid. The three cinnamic acids would then be assigned the formulas

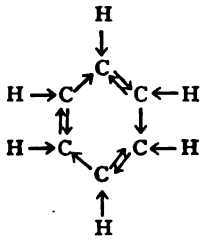
$$C_6H_5CH\rightleftarrows CHCO_2H;\ C_6H_5CH\rightleftarrows CHCO_2H;$$

and $C_6H_5CH\rightleftarrows CHCO_2H$.

Ordinary cinnamic acid, melting at 133°, should probably be assigned the first structure, while the other two structures belong to allocinnamic acid, melting at 68° and isocinnamic acid, melting at 36–37°, but which is which it is impossible to state at present. Cinnamic acid appears to be the only well authenticated case at present in which three isomers of a doubly-bonded carbon compound exist. The reason for this may be found in the fact that if the two halves of the molecule are made up of groups differing very much in properties, of the two isomers in which both valencies act in the same direction, one will exhibit very much greater stability than the other, making it extremely difficult, if not impossible, to isolate the more unstable form. The reaction recently described by Michael and Bunge,* according to which both the fumaroid and maleinoid crotonic acids add chlorine in either sunlight or the dark to form the same maleinoid dichloride can readily be accounted for with directive valencies.

* *Ber.*, *41*, 2907 (1908).

Applying the conception of directive valencies to benzene, the following representation is obtained :



or the carbon atoms 1, 3 and 5 contain three negative and one positive charge (three corpuscles added and one removed), and the carbon atoms 2, 4 and 6, two negative and two positive charges. This involves the same points which were raised with respect to Kekulé's original benzene structure. Without going as far at present as to assume an oscillation of corpuscles between the carbon atoms (corresponding to the oscillation of the double bond), it may be assumed that in all benzene derivatives one form is very much more stable than the other, and that the unstable form will rearrange spontaneously (by the motion of corpuscles within the molecule) to produce the most stable configuration in any given case. It may be possible, however, to isolate the unstable modification in some cases. Ostromisslensky * describes two forms of the following compounds, calling them α and β modifications and giving the differences in melting points between the two :

	Differences in Melting Points of α and β.
o-Nitrotoluene	6.4°
o-Chlortoluene	5.8
o-Toluidine	5
o-Chlorphenol	7
o-Bromtoluene	5.1

The groups attached to the benzene nucleus differ widely in the different compounds, but the differences in melting points are very nearly the same, indicating a common cause for the existence of two isomers in each case. Considering the substituents as being in the 1, 2 and in the 2, 1 positions in the different compounds would perhaps give a common cause and account for the two isomers. Knoevenagel † gives the difference in melting points

* *Z. physik. Chem.*, 57, 341 (1907).

† *Ber.*, 40, 508 (1907).

between the two forms of o-nitrotoluene as 5.8°, between the two forms of o-toluidine as 5.5°, and between two forms of o-chloraniline as 10.5°.

The introduction of directive valencies into the benzene nucleus shows that the two ortho and the para carbon atoms are alike and therefore would bear the same relation to a substituent in position one, while the two meta carbon atoms are alike and bear the same relation to position one. Perhaps an explanation of the effect of a group attached to the benzene nucleus in determining the position of the entering group may be found on this basis.

With regard to carbon compounds containing a triple bond, there are evidently many possibilities in the way of drawing formulæ involving directive valencies, most of which are entirely unnecessary, if not actually incapable of realization, at the present time, since very few, if any, isomeric compounds of this kind are known. It may be shown, however, that the stable form of triple-bonded compounds is in all probability best represented by the structure $RC \rightleftarrows CR'$. Taking acetylene dicarboxylic acid, perhaps the simplest example which could be chosen, treatment with 10 per cent. hydrobromic acid at ordinary temperatures for five days yielded brom-fumaric acid, the conditions being such that brom-maleic acid would not be transformed into brom-fumaric acid.* The same was found in the case when hydrochloric acid was used. The reaction here is

$$(CO_2H)C \rightleftarrows C(CO_2H) + HBr = (CO_2H)BrC \rightleftarrows CH(CO_2H)$$

Bromine and acetylene dicarboxylic acid yielded 30 per cent. dibrom-maleic acid and 70 per cent. dibromfumaric acid. Considering the structure of acetylene dicarboxylic acid

$$(CO_2H)C \rightleftarrows C(CO_2H)$$

and the reagent bromine, it is evident that there is the same chance or tendency of addition to each of the three bonds, or that one third of the compound would be transformed into

$$(CO_2H)BrC \rightleftarrows CBr(CO_2H)$$

and two thirds into $(CO_2H)BrC \rightleftarrows CBr(CO_2H)$.

* Michael, *J. pr. Chem.* (2), *46*, 210 (1892).

The study of the compounds of nitrogen in which directive valency (or transfer of corpuscles) takes the place of the usual method of linkage between the atoms, may be pursued in the same way as with the compounds of carbon. Nitrogen has the power of taking up three corpuscles, as shown by ammonia, or of losing five. The latter cannot be seen directly since the compounds of nitrogen with the univalent elements capable of taking up corpuscles (namely, the halogens) are unstable under ordinary conditions, but is evident from the compounds of nitrogen with oxygen. The difference between the two extreme states of nitrogen would be eight units of valency, or nitrogen in ammonia differs from the nitrogen in nitric acid by eight corpuscules. The difference between the nitrogen in ammonia ($N\overset{\leftarrow}{\underset{\leftarrow}{}}H_3$) and the nitrogen in nitrous acid ($O\overset{\leftarrow}{\underset{}{}}N\rightarrow O\leftarrow H$) would be six corpuscles. The difference in the direction of the valency (or the loss or gain of corpuscles) can be followed much more readily with the nitrogen than with the carbon compounds, since a greater, or perhaps better, a more evident difference in the properties of the compounds results, making it fairly easy to follow a given nitrogen atom containing a certain charge through a series of compounds and their derivatives. This point of view has been recently brought forward very clearly by J. Stieglitz in a review * of "The Chemistry of the Diazo-Compounds" by John Cannell Cain, in which ammonia nitrogen is spoken of as N^{---} and nitrous acid nitrogen as N^{+++}. Nitrogen in addition to being able to take up three corpuscles, is able to take up a fourth, if at the same time one is also given up, ammonium compounds being formed. With the compounds of nitrogen, just as with carbon, if an element or group is united by means of a single bond, this bond may be assumed to have a definite direction depending upon whether the element or group is electro-negative (capable of taking up corpuscles) or electro-positive (capable of giving up corpuscles) toward the nitrogen. This would hold for N^{---} to N^{++++}, but in the formation of ammonium compounds from N^{---} it would not be surprising if this rule would have to be modified somewhat. As a possible example of this may be quoted a recent article by Meisenheimer,† in

* *J. Am. Chem. Soc.*, *30*, 1797 (1908).

† *Ber.*, *41*, 3966 (1908).

which he considered it probable that in methyl-ethyl-phenyl-hydroxyl-ammonium hydroxide, the two hydroxyl groups are united to the nitrogen by unequal valencies.

In hydrazine, using directive valencies, the two nitrogen atoms should have different properties ($H_2 \rightleftarrows N \rightarrow N \leftarrow\!\!\rightarrow H_2$). This is generally disposed of by the statement that hydrazine is a weak base, combining with two molecules of hydrochloric acid, but one of which is given off much more readily than the other. If the two nitrogen atoms are equal in hydrazine, there should be no reason why both molecules of hydrochloric acid should not bear the same relation toward the molecule (except that the presence of the one hydrochloric acid molecule changes the properties of the substance, which is a re-statement in an inverted form of the fact), but using directive valencies, a difference would be expected. Substituting the hydrogen atoms of hydrazine by different groups, in general only one compound would be stable even if an isomer should be formed under exceptional circumstances (for instance $RHN \rightarrow NHR'$ and $RHN \leftarrow NHR'$). If the entering groups do not differ from each other too greatly, it would be possible to isolate such unstable isomers in some cases. This appears to have been done by Willgerodt * by the reaction between dinitro-chlorbenzene and phenyl-hydrazine or α- or β-naphthylhydrazine, and perhaps in other cases.

The compounds of nitrogen containing a double bond would include the azo and diazo derivatives. With regard to the azo derivatives, the possibilities of isomerism would be less than with the carbon compounds limiting the study to trivalent (positive or negative) nitrogen. It will not be necessary to go into very great detail here, since very few isomers have been described. Since, in all azo compounds, no difference has been observed, in the two-nitrogen atoms, it is fair to ascribe to the stable form, and in general the only known form, of the azo compounds, the formula $R \cdot N \rightleftarrows N \cdot R'$ analogous to the stable form of the ethylene isomers. The only certain isomer among the azo compounds which has been observed and which would be derived from the structure in which both valencies act in the same direction is p-azophenol.†

* *J. pr. Chem.* (2), *37*, 449, and *43*, 177 (1888 and 1891).

† Willstätter and Benz, *Ber.*, *39*, 3492 (1906), and *40*, 1578 (1907). For possible isomers of this group, cf. the list of references given by Jacobson and Königsberger in the footnote, *Ber.*, *36*, 4123.

In taking up the diazo compounds it will be necessary to include the diazonium compounds, which will be treated of first. These are derived from ammonium salts in which the three hydrogen atoms are replaced by one nitrogen atom which shows similar properties. The formula of the diazonium salts may therefore be represented by

$$\begin{array}{l} R \cdot N \overleftarrow{\leftarrow} N \\ \quad\downarrow \\ \quad X \end{array}$$

one nitrogen being the ammonia nitrogen combined with RX, the other being the nitrous acid nitrogen (N^{+++}). For the syn and anti diazo compounds there are evidently the two formulæ containing the groupings $\cdot N \overleftarrow{\leftarrow} N \cdot$ and $\cdot N \leftrightarrows N \cdot$ possible. In the formation of diazo compounds from a primary amine and nitrous acid, the first product formed is always the syn compound making it extremely probable that these are derived from the grouping $R \cdot N \overleftarrow{\leftarrow} N \cdot X$ or $R \rightarrow N \overleftarrow{\leftarrow} N \rightarrow O \leftarrow H$, the ammonia and nitrous acid nitrogens retaining their charges intact. Syn compounds can very readily be converted into anti compounds, most simply by the action of alkalis in solution, but anti compounds cannot be converted directly again into syn, showing that the anti form is the more stable. This is also brought out by comparing some of the physical properties * of the two series. The anti diazo compounds may then be assigned the structure $R \rightarrow N \leftrightarrows N \rightarrow O \leftarrow H$ analogous again to the stable forms of the ethylene isomers in which the two valencies also act in opposite directions. The chemical reactions which show the syn compounds to be more reactive than the anti are their greater explosiveness and the fact that they can be more easily reduced and oxidized. In coupling the syn compounds also show their great reactivity as compared with the anti, but this reaction would tend to show that azo derivatives are derived from the unsymmetrical structure considering directive valency. It is necessary to assume a shift of a corpuscle here in the azo compounds, since as stated before the two nitrogens in the azo compound have not been found to differ in properties and all the reactions and method of formation of the syn diazo compounds point to the structure already assigned to them.

* The syn compounds are more soluble and show a lower melting point than the anti.

The relation between syn diazo compounds and diazonium compounds is a very close one. They are readily transformed into each other, alkalis favoring the formation of the diazo derivatives, acids of the diazonium, while in solution both exist in equilibrium testifying to the readiness with which they are transformed into each other. All this is readily understood when directive valencies are used, the structures of the two classes being represented by

$$R\rightarrow N\rightleftarrows N\rightarrow X \text{ and } R\rightarrow N\overset{\downarrow X}{\rightleftarrows} N$$

the X group or element (electro-negative toward nitrogen as the direction of the valency shows) shifting its position from the one nitrogen to the other.

The replacement of the diazo group by other groups on the benzene (or naphthalene) nucleus is a well known and characteristic property of these compounds. The more unstable syn derivatives decompose in this way fairly readily, the ease, of course, depending to some extent upon the substance used, while with the anti derivatives these reactions either do not occur, or at the best are very slow in their progress. The greater reactivity of the syn compounds would perhaps account for this, but it seems possible in this case to look for a deeper underlying cause. The great variety of groups which combine with the benzene nucleus when the nitrogen is eliminated, including hydroxyl, alkoxyl, halogen, cyanogen, sulphur, sulphonic acid, aromatic hydrocarbon residues, etc., show that the reaction is not limited to any one group or class. The common phenomenon in all these reactions is the elimination of nitrogen and the cause of the reaction may justly therefore be put to the tendency of the nitrogen to be set free. The difference in the nitrogen in the syn and diazo compounds may be represented by $\rightarrow N\rightleftarrows N\rightarrow$ and $\rightarrow N\underset{\rightarrow}{\overset{\leftarrow}{\rightleftarrows}} N\rightarrow$ and upon being set free, if the trivalent nitrogen still persists, the syn would be represented by $N\rightleftarrows N$ and the anti by $N\underset{\rightarrow}{\overset{\leftarrow}{\rightleftarrows}} N$. If the trivalent property becomes transformed into some other then there appears to be no reason why one form should give off the nitrogen any more readily than the other. The reaction is then referred back to the tendency of the nitrogen in the diazo compounds to form the nitrogen mole-

cule $N \rightleftarrows N$. This leads to the conclusion that in the nitrogen molecule, the two atoms are charged differently, one positively, the other negatively. The same fact is indicated by the formation of nitrogen when ammonium nitrite is heated, and the reverse reaction. J. J. Thomson * inclines to the view that in molecular oxygen, the two atoms are charged differently, one atom having lost one or more corpuscles, the other gaining them. This is analogous to the view developed for nitrogen, and would lead to the conclusion that molecules composed of two or more of the same kind of atoms are held together by electrical forces in the same way as molecules composed of two or more dissimilar atoms.

The compounds of nitrogen offer a more interesting field for the development of the conception of directive valency than the compounds of carbon since it is simpler to determine the direction of the valency, or the sign of the electric charge, of the nitrogen atom in any given case and to follow it through a series of transformations than in the case of the carbon atom. The general underlying conceptions have been spoken of and the further development of the subject may be left for the present.

Taking up now the next group in the Periodic System, oxygen would be the element to be considered. The two different valencies are not shown as clearly in oxygen as in the next member of the group, sulphur, which will be spoken of instead. The sulphur atom is capable of taking up two corpuscles, as shown in the formation of hydrogen sulphide and the metallic sulphides, and of losing six, as shown in sulphur trioxide (also SF_6). The state of the sulphur in any compound can readily be determined from the properties of the compound, and since the amount of work on sulphur compounds is very much less than with the compounds of carbon and nitrogen, it will not be necessary to enter into the details of the possible case of isomerism, since none have been shown experimentally to exist. The same holds true for the compounds of oxygen, although attention may be called to an interesting possibility. Hydrogen dioxide, if represented by the formula $H \rightarrow O \rightarrow O \leftarrow H$ shows the oxygen to be in two different states here and may account for some of the apparently peculiar reactions of the substance. The same would be true if the tautomeric structure $H_2 \rightrightarrows O \leftleftarrows O$ is assumed. The

* *Loc. cit.*, p. 140. See also p. 130 for the general views.

facts of autoxidation may also find a more ready explanation assuming differently charged oxygen atoms in the oxygen molecule.

The elements of the seventh group of the periodic system (the halogens) show properties similar to the elements of the sixth group. One electron can be taken up and seven lost, the total difference in the properties of the halogen being due to a difference in valency of eight units or of eight corpuscles. Isomerism has not been observed here either, so it will not be necessary to enter into a discussion of the possibilities.

The sulphonium and iodonium derivatives are similar to the ammonium. Although sulphur can take up only two corpuscles to form stable compounds, a third can be taken up, if at the same time one is lost, leaving the total electrical charge the same but having different lines of force emanating from the sulphur atom in the two cases. In the same way, iodine can take up a second corpuscle, if at the same time one is given off to another element or group, iodonium derivatives being formed.

So far isomerism caused by two atoms of an element combining in different ways which was explained as being due to the difference in the direction of the valency, has been considered chiefly. The same principles should be applicable to combinations of different elements and the possibitities of isomerism due to the double bond in these cases should follow analogous rules. Following the reasoning used in the example already discussed, it is possible to limit the cases of possible isomerism somewhat in considering combinations of two dissimilar elements. When two dissimilar elements unite by a single bond, the direction in which the corpuscle is moved in order to establish this linkage is, in general, perfectly definite, the opposite direction occurring only under exceptional conditions. If a second linkage (or double bond) is established between the two atoms, the direction in which the second corpuscle moves will either be the same or opposite to that of the first corpuscle, giving rise to two isomeric compounds of the same structure differing only in the direction of one valency. These two isomers would differ in stability, and the more stable one may for the present be assigned the structure in which both valencies possess the same direction, since this appears to be the most reasonable view in the union of two dissimilar atoms. This sub-

ject may be exemplified by the carbonyl group as occurring in various organic compounds. Following the reasoning given, the structure : $C\rightleftarrows O$ would be the stable one; if isomers occur, the grouping : $C\rightleftarrows O$ would be assigned to these, whereas the grouping : $C\leftrightarrows O$ would be so unstable as to render the compounds in which it might be expected to exist, too unstable to be isolated. These stable isomers differ in structure then from the stable isomers in which two carbon or two nitrogen atoms are united by a double bond, the direction of the two valencies being opposite to each other in the latter, in the same direction in the former.

A large number of isomeric compounds containing a double bond between two unlike atoms are known. To begin with the simplest case of all, benzophenone, is known to exist in two modifications, one stable, the other labile and going over into the stable form with great ease. Of these modifications, the stable one, melting at 48.5°, may be assigned the structure $(C_6H_5)_2C\rightleftarrows O$ and the labile one, melting at 25°, the structure $(C_6H_5)_2C\rightleftarrows O$. Other ketones are known existing in two modifications of which may be mentioned p-tolylphenylketone, stable variety, melting at 59–60°, labile variety melting at 55°, fluorenone, and probably others. Perhaps the two forms of o-quinone* and of diphenoquinone† belong to this group. The α- and β-pinacolins may find their explanation in assigning them similar structures and explaining their different behavior as due to the difference between the two forms caused by the difference in direction of the one valency. A group of substances derived from the ketones, or in general from compounds containing the carbonyl group, occur in isomeric forms which may be explained in the same way as with the simple ketones. The classes showing this isomerism are the oximes, hydrazones, semi-carbazones, chlorimides, etc. It seems hardly necessary to enter into any details with regard to the structures of these classes of compounds, since the method of treatment is the same as that already used, and the stability and other relations would be taken up similarly. A few lines may, however, be devoted to the oximes. On treating an aromatic aldehyde with hydroxylamine directly, the "anti" aldoxime is formed first and can be converted into the

* Willstätter and Müller, *Ber.*, *41*, 1580 (1908).

† Willstätter and Kalb, *Ber.*, *38*, 1232 (1905).

"syn" form by suitable treatment. From this, the anti form would be assigned the structure $RH:C \rightrightarrows N \rightarrow O \leftarrow H$ and the syn form the structure $RH:C \rightleftarrows N \rightarrow O \leftarrow H$. The different properties of the two forms of the aldoxime would then be due to the difference in linking between the carbon and nitrogen atoms in the two cases. Similar reasoning applies to the ketoximes, the structure to be assigned to the two forms differing in the union between the carbon and nitrogen atoms and the reactions of these forms differing according to the influence of that union. In the Beckmann rearrangement, the group which would exchange positions with the hydroxyl depends upon the nature of that group as compared with the nature of the nitrogen atom.

The structural formulæ considered so far have been assumed, as is general in organic chemistry, to be perfectly definite in any case, the linkings between the atoms, as determined by the reactions, decompositions and syntheses of the substances being fixed in position and not moving indiscriminately within the molecule. There remains to be considered the group of substances which behave towards one set of reagents as though possessing a certain structure and towards another as though possessing a different structure, the difference consisting in most cases in the change in position of a hydrogen atom. This group of substances are included under the general grouping of tautomeric substances, although there have been various subdivisions with different names introduced. Using the conception of the transfer of a corpuscle as being the cause of the establishment of a linking, as represented in organic compounds, it is evident that the difference between the two forms of a tautomeric compound would consist of the difference in position of a corpuscle in the molecule and that it would not be necessary to assume the actual transfer of an atom from one part of the molecule to another, including a breaking and making of bonds, but the motion of a corpuscle from one atom to another, together with the motion of the line or tube of force which holds it to the atom from which it was separated originally. This brings up the point, that if corpuscles are the chief factors involved in the difference of structures between the two forms of a tautomeric substance, tautomerism should be exhibited with other atoms or groups besides hydrogen. Acree recently proved that the sodium

and silver salts * of 1, 4-dialkyl-3-hydroxy-5-thiourazole, exist in two forms each and are tautomers. Since tautomeric substances are, however, the exception rather than the rule, the rhythmical shifting of a corpuscle in a molecule in this way is apparently not as common as would appear at first sight. There is, however, another phase of the subject which has come into prominence lately; namely, the study of absorption bands leading to the theory of isorropesis.† According to this view, whenever an absorption band is found in the spectrum of an organic substance, a process of vibration is going on within the molecule; with tautomeric ketone-enol substances, between the forms represented by the two structures, with substances containing double bonds (such as the benzene ring) the vibration or oscillation takes place by the double bond shifting in position. The carboxyl group in compounds gave a definite absorption band whose persistence was proportional to the reactivity of the substance, or as Stewart and Baly stated, the *nascent carbonyl group* was formed in the vibrations or oscillations between two or more forms of the substance, these same vibrations causing the absorption band. They show further, that in this case, when other groups in the molecule retard reaction, this retardation need not be referred to "steric hindrance," but to the interference of these groups with the formation of the nascent carbonyl group, or in other words with the oscillation. Using the electron conception of valency, tautomerism is caused by the oscillation of a corpuscle between two fixed positions in a molecule together with a regular motion of the tube of force, and it would not be surprising if a motion of this sort caused an absorption band to appear in the spectrum of the substance. The resulting deductions and conclusions of Stewart and Baly can, therefore, be carried over bodily to the conception of valency elaborated in this paper, and not only do they fit in perfectly but add greatly to it and indicate methods of testing the conception further.

While taking up the optical phenomena, the conclusion of Brühl ‡ with regard to the study of refractive indices may be noted. In studying the compounds of nitrogen, he found that it

* Reported at the Annual Meeting of the American Chemical Society, December, 1908.

† Stewart and Baly, *J. Chem. Soc.*, *89*, 489.

‡ Final paper, *Z. physik. Chem.*, *25*, 576 (1898).

was not possible to assign a definite value to the atomic refraction of nitrogen in the large number of compounds studied, but that the value appeared to be different depending upon the elements with which it was combined. He concludes that the valency hypothesis is weakest in these compounds. Perhaps light may be thrown upon their relations if directive valencies are used.

In this paper an attempt has been made to extend J. J. Thomson's views of the linking of atoms with each other by the transfer of a corpuscle to the compounds of organic chemistry, and a number of cases of isomerism occurring with these compounds have been explained in this way. The cases involving geometrical isomerism are those which have been considered principally and for which possible explanations have been given without considering spatial relations at all, by the addition to the ordinary conception of the bond between two atoms the idea that this bond possesses a definite direction. The compounds of nitrogen together with the isomerism which has been observed with many of them are referred to exactly the same underlying principles, while with the compounds of other elements where similar possi bilities might be expected, the experimental material is at present too scanty to permit of any satisfactory elaboration.

COLUMBIA UNIVERSITY, NEW YORK.

THE VALUE OF GAS POWER.*

By CHARLES E. LUCKE.

Power generation for whatever purpose should be considered as a manufacturing problem in which power is the product of the power factory or plant and some form of fuel in general, together with water, lubricating oil, repair and cleaning material constitute the materials, and the means of manufacture; men and machinery. The cost of the manufactured product is dependent on the consumption of material and the expenditure of labor and capital invested in the machinery and other equipment. On this basis the selection of machinery for a power plant becomes a question of commercial engineering, carrying with it a strictly technical element of adaptability to the service. Given several types of possible engines and auxiliary power apparatus as equally adaptable as is generally the case the ultimate selection must depend on the capability of the apparatus to manufacture power at lowest cost, all charges being properly considered.

In recent times the gas power plant involving gas producers for transforming solid coal fuel into fixed gas, together with gas engines for internally burning this gas and transforming some of the heat of combustion into work, has become a commercial competitor of the steam plant burning the same fuel under boilers. The first claims for recognition on the part of the gas engine were probably scientific rather than commercial and based on thermodynamic demonstrations of the inherently higher thermal efficiency of this method of transforming heat into work over the steam method. For perhaps a quarter century small gas engines were built and sold and while incapable of giving service as good as steam engines failed to compete chiefly because of the inability to use coal fuel. Experiments and study in large blast furnace plants in Europe resulted in a better designed mechanism and better engines, which, together with the gas producer developed and adapted for supplying them efficiently with gas from coal fuel, made possible the more complete competition of the gas with the steam power plant.

* Reprinted from Proceedings of Pan-American Scientific Congress, Santiago, Chile, December, 1908.

So far as adaptability to the load requirements is concerned the modern gas power plant competition with the steam plant is complete, but commercial competition on the basis of power cost is on the same basis as the various types of steam plants with each other. A comparison of gas with steam power plants will show that the principal differences are not in the labor, lubricating, cleaning and repairing costs but rather in coal and water consumption per horse-power hour, in first costs and life. The gas power plant is unquestionably more efficient thermally than the steam plant and likewise generally more costly. The coal cost of operation will be lower for the gas plant and higher for the steam plant, but this saving is offset by an increased fixed charge due to higher first cost and in some cases shorter life and greater property and building charges due to space occupied.

There is no longer any necessity for scientific demonstration of the possible high efficiencies of the gas engine and producer, but there is need of much information on actual coal consumption under the various conditions which affect it as well as definite information on some of the characteristics of the gas power installation to permit of power comparisons with steam plants which are so much better known.

One very important characteristic of steam plants is the wide variation in their coal consumption per horse-power hour with size, and this is in striking contrast to the gas plant in which the coal consumption is practically independent of size. It will be found that the best steam plants of large size are so economical of coal and cost so little in comparison with equal sized gas plants that the gas plant cannot compete at present in power cost. This is especially true when coal is cheap because in this case the coal charge is a small fraction of the total power cost and the low fuel consumption of the gas plant involves a saving of on what is only a small item. The gas plant suffers by comparison whenever the load factor of the plant is low, that is, when the total output in horse-power hours per year is low in comparison with total possible output for every day and all day operation at full load, because the fixed charges are a yearly sum and small output increases the fixed charges per power unit. There is, however, some offset to this load factor element in as much as low load factor generally involves considerable stand-by losses especially when the load fluctuations are sudden, and as the gas plant stand-by losses are less than for

the steam plant there would be a tendency to equalize in cost of stand-by fuel the gas plant's excess of first cost fixed charges over the steam plant.

In view of the above the gas power plant is to-day practically no competitor of the steam plant in larger sizes where coal is burned except when coal is exceedingly high, higher than in most places in the United States. It is, on the contrary, a most formidable competitor in small sizes, the more so the higher the cost of coal, and the smaller the size, so that the gas power plant which is most economical in power cost in comparison with steam and which will be most used in the future will be in the medium sizes involving units from 50 to 350 H.P., singly or combined up to any number. It must be remembered that combination of small units will prove quite an efficient combination with gas plants because of the constancy of efficiency with size. This is not the case with steam plants and has led to the practice of using steam engines as large as possible up to what is convenient to handle. A gas plant of 2,000 H.P. will have about the same efficiency at full load with one 2,000 H.P. engine as with two 1,000 H.P. engines, four of 500 H.P. or twenty of 100 H.P., while on part plant load the smaller the individual units the easier it will be to keep up the efficiency. A single engine will have its highest efficiency at about full load and will lose efficiency rapidly as the governor operates under part engine load. Units of the standard type engines halve their efficiency and double their fuel consumption per H.P. hour at about one fourth load. On this basis at 500 H.P. the single engine would have doubled its fuel consumption and its fuel cost per horse-power hour whereas four of the 500 H.P. or twenty of the 100 H.P. carry the same load by shutting down the others would have suffered no fuel loss. This fuel cost effect of variation of individual engine load factor must not be confused with the fixed charge effect of change in plant load factor which is the same no matter what the size of the units.

If a steam plant cost $75 per H.P. and a gas plant $125 then interest charge at 5 per cent. involves a charge of $3.75 per year for steam and $6.25 per year for gas. In a year there are 8,760 hours so that if the plant worked every day and all day the fixed charges would be $3.75 per H.P. year steam and $6.25 per H.P. year gas or .0428 cent per H.P. hour steam and .0713 cent per H.P. hour gas. If the coal consumption were 2 lbs. per H.P. hour for

steam, which is good and equalled only in large and efficient plants, and the coal cost $3.00 per ton of 2,000 lbs. or .15 cent per lb., then the coal cost per H.P. hour for steam would be .30 cent. To overcome the difference in fixed charges of (.0713 — .0428) = .0285 cent per H.P. hour the gas plant would have to operate on .6285/.1500 = .18 lb. less coal or have a consumption of 2.00 — .18 = 1.82 lbs. per H.P. hour, which it can easily do. If, however, the plant operated full load for only one fifth time the fixed charges per H.P. hour would be five times as much and the fuel saving to overcome this must likewise be five times as much or 5 × .18 = .90 lb. requiring a fuel consumption of 1.1 lbs. per H.P. hour for the gas engine which is difficult but possible. When, however, the low load factor is obtained not by full-load operation for a shorter time but by both part time operation and part load operation of the individual unit then the coal consumption of both plants would rise, but would rise more for the gas than for the steam especially if the steam engine had a fairly flat steam consumption load curve. In this case the gas engine plant probably could not compete on the above assumptions. It would be still more difficult for the gas plant to compete if coal were $1.00 per ton as it is in the coal districts and often much less. At this price the coal cost per H.P. hour would be only one third or .100 cent and the difference which the gas plant must save for 100 per cent. load factor 3 × .18 = .54 lb. requiring an operation of 1.46 lbs. per H.P. hour also a possibility, and for the full load 20 per cent. of its time, 3 × 5 × .18 = 2.70, which is more than is burned, and therefore, utterly impossible. The competition between first cost, load factor, fuel cost and relative fuel consumption is thus most in favor of the gas plant when fuel is high, load factor high, the size of the plant small and a number of small gas engine units in use instead of a few large ones.

It is such conditions as these that fix the best field of the gas power plant as that in which the medium and small unit can best be employed. Experience in Europe, and later but quite surely in America, has developed one typical form of this medium-sized engine having a horizontal, single-acting, four-cycle cylinder, expanding cylinder liner, exhaust and inlet valves vertically in line in the head at the cylinder axis, electric ignition, a throttle governor and moderate speed and great rigidity of construction to permit long life. In order that the information presented on the characteristics of the

0.2
0.25
0.5
0.5
0.75
0.75

1 13/16"
0.0"
0.0"
0.0
0.0
0.7"
1"
1.0"
1.0"
1.0
1.0"
1.5
1.5

most useful medium-sized gas power units shall be definite the product of the De La Vergne Machine Company of New York has been selected as typical of the high class machinery having a cost probably as high as any. The cut, Fig. 1, shows the engine and

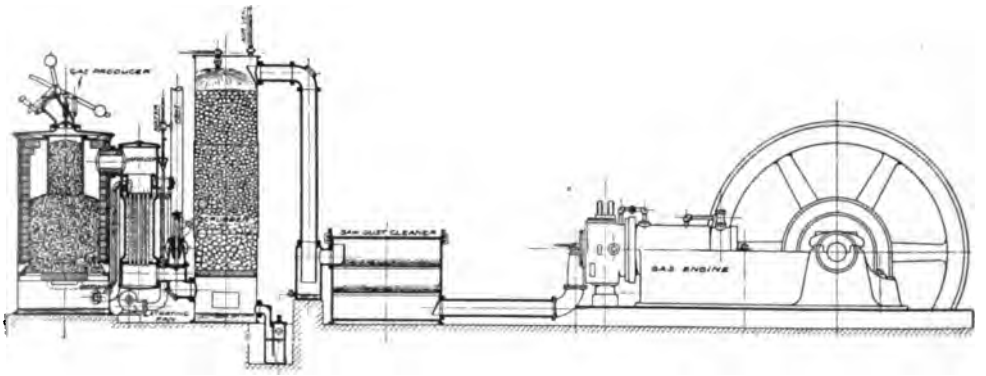


FIG. 1.

suction producer, in section. The engine is shown more in detail, Figs. 2, 3, 4. Some of the important dimensions, with the weights and space occupied and the cost, are given in the following table, I. These costs are approximately correct, but are not to be taken except as guides because constantly changing commercial or trade conditions will cause them to change most unexpectedly. The

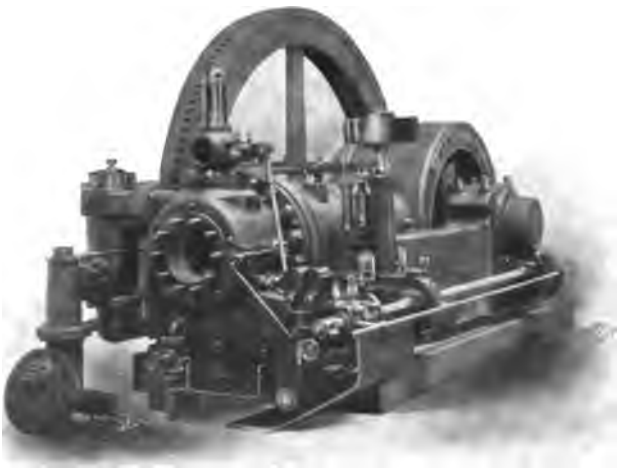


FIG. 2. Engine with head removed.

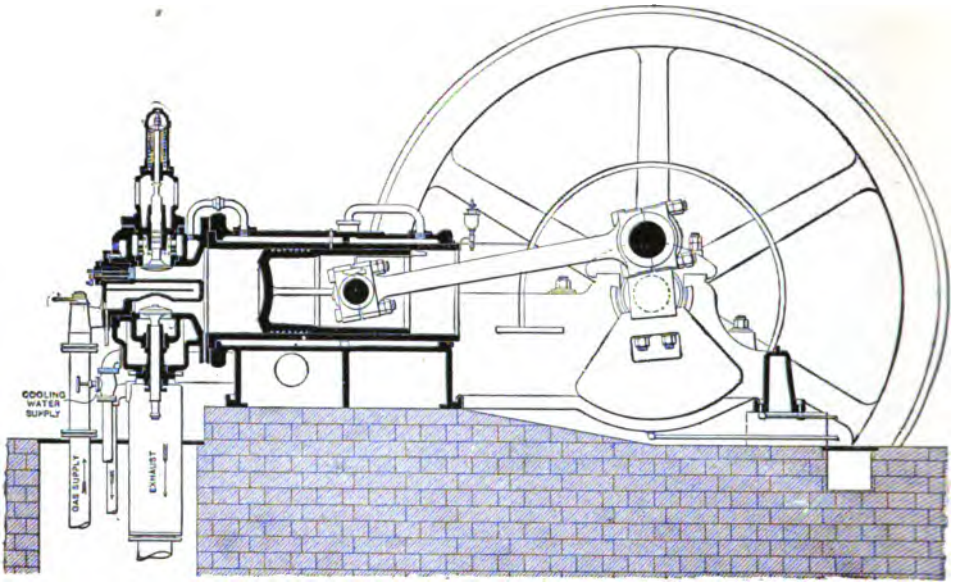


FIG. 3. Cross-section of engine through cylinder and valves.

Brake horse-power rating is based in all cases on 68 lbs. mean effective pressure and a mechanical efficiency of 82 per cent.,

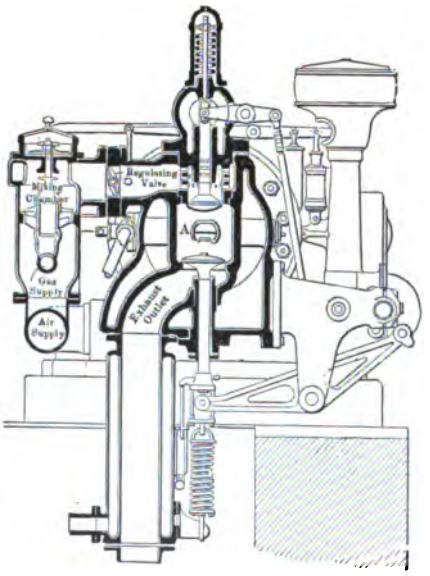


FIG. 4. End view of engine cross-sectioned through head at valves and running valve.

although the maximum mechanical efficiency is closer to 88 per cent. actually and the possible mean effective pressure 87 lbs. with good gas and careful adjustment, as is shown by the following cards, Fig. 5, taken from one of these engines of 75 H.P. This large margin of rating conditions over maximum possibilities is allowed not so much to permit the carrying of overloads as to permit of maintaining full rated load without the best adjustments or with poor gas.

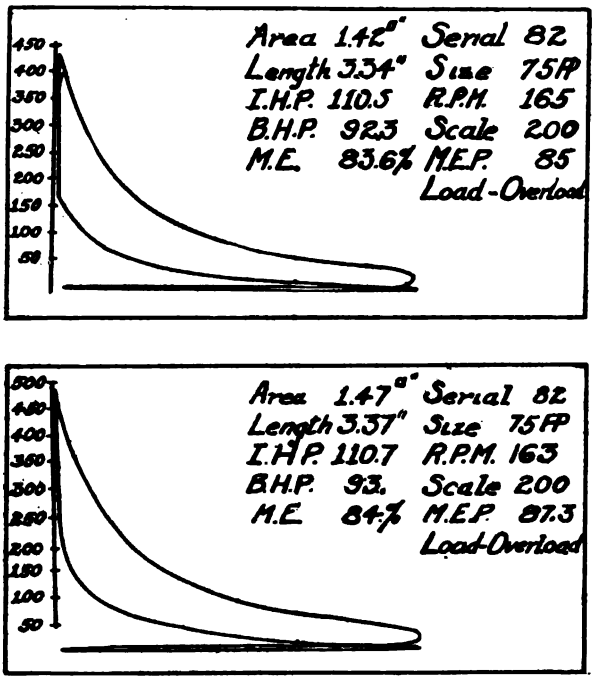


FIG. 5.

The square feet of enclosing rectangle is useful in estimating floor space and real estate necessary and runs about two square feet per horse-power for single engines with out-board bearings and between 1½ and 1¾ square feet per horse-power for twin engines carrying the driving pulley or electrical generator between them. Data on the cubic feet of enclosing prism is valuable in estimating building requirements and appears from the table to vary from 16.0 to 20.0 cu. ft. for single and 13.0 to 16.0 cu. ft. per horse-power for twin engines. Concrete requirements for engine foundations refer to the material necessary to hold the engine only, but not to the

sub-foundation necessary for a proper bottom on any particular soil. The cu. ft. of concrete per H.P. is about 12 or 13 for single and about 10 for twin engines. Weights of the engine complete including the fly-wheels allow of estimating transportation costs and serve also as a check on prices as some machines, especially gas engines, are made very heavy to secure rigidity rather than strength. Rigidity is very important, as experience has proved that the life of an engine for continuous service is strongly dependent on it, so extra weight is a good investment. The heavy fly-wheels are desirable for electrical drives, or in cases where steady rotation is needed, while the light fly-wheels suffice for most belt and pump drives. By the table, the weight per horse-power of these engines, single with the heavy fly-wheel, lies between 530 and 590 lbs. and for twin engines between 420 and 445 lbs., in striking contrast to some automobiles and boat engines which by reason of high speed and light construction are as light as 25 lbs. per H.P., but which have a short life even with their intermittent service.

The cost of these engines varies from $52 to $43 per horse-power single, and $46 to $36 per horse-power twin, which is apparently high when it is possible to buy multiple cylinder engines of higher speed and lighter construction for as low as $25 per horse-power in the larger of these sizes and $36 in the smaller. The explanation is largely to be found in the weight and is indicated by the low cost per lb. which varies from 7½ to 9½ cents for single engines and 8½ to 11 cents for twin engines. It is interesting and instructive to compare these apparently high gas engine costs with the costs of other standard machinery on the pound basis. Thus, for the common duplex steam pumps of various patterns and sizes the cost will vary from 10 to 30 cents per pound, the high price applying to the smaller sizes. Steam and belt driven air compressors of one and two stages, single and duplex, simple and compound steam ends vary in price per lb. from 9 cents to 35 cents, the price not varying with size only but with complications, and the larger sizes comparing in weight with the gas engines considered, the minimum compression cost comparing with the maximum of the gas engines. Some of the cheaper gas engines, selling for as low as $35 per H.P., will be found to have pound-costs as high as 18 cents. There is in fact very little power machinery built that will come under the minimum limits of these gas engine costs, 7½–11 cents; there are

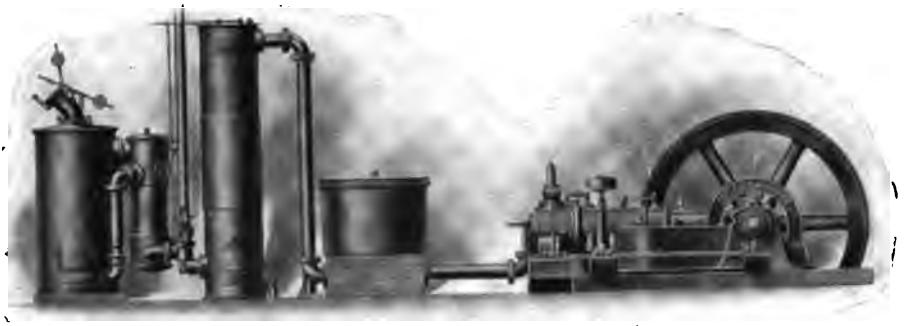


FIG. 6.

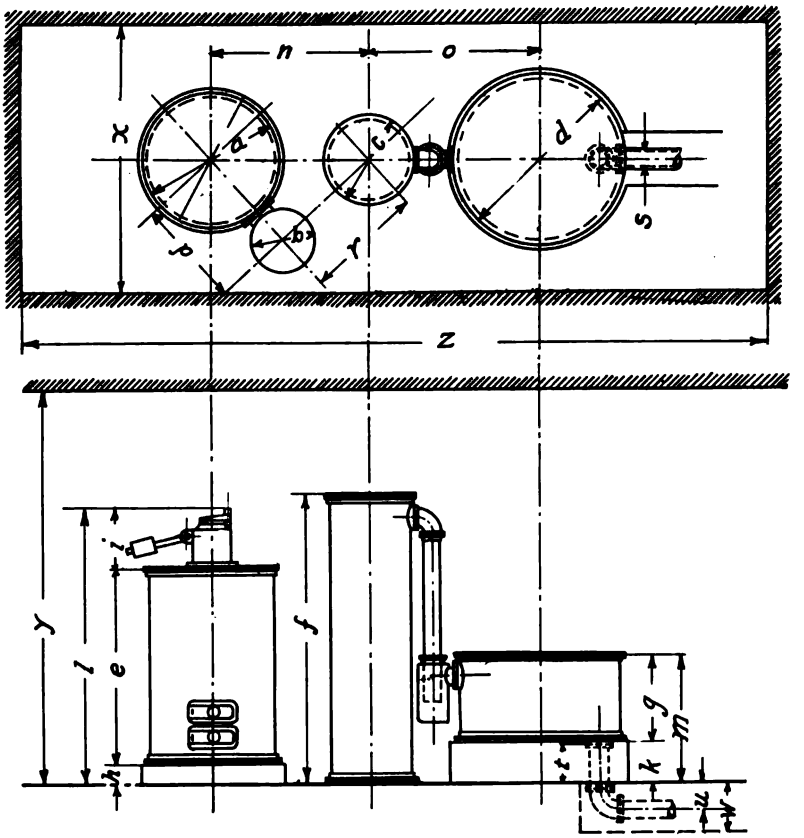


FIG. 7.

records of large Corliss engines costing as low as 6 cents, but this is unusual; simple, high speed engines will run from 15 to 25 cents per lb. in the same weights as these gas engines.

The gas producers are built to operate with the fire and ash pit under pressure or with the fire under a slight vacuum and the ash pit approximately at atmospheric pressure, but for simplicity only the suction producers will be considered and these are illustrated in Fig. 1, Fig. 6 and Fig 7. They are adapted to anthracite coal and

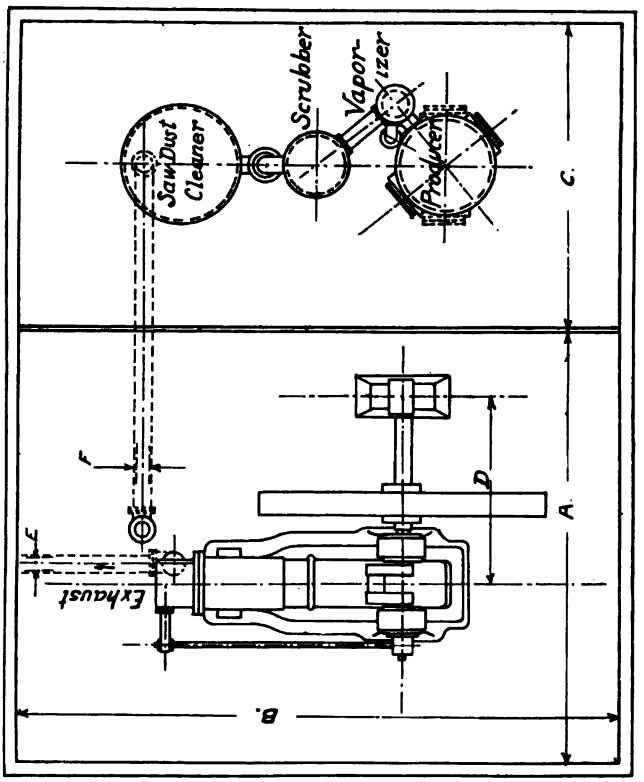


FIG. 8. Arrangement of single suction producer and single-cylinder engine for direct connection.

coke, and while they will operate on some bituminous coals the trouble and expense due to caking in the producer and tar in the gas make this field not so attractive. The rating of the producers is based on a combustion of 15 lbs. of anthracite and 11 lbs. of coke per hour per sq ft. of grate bed. Variations in fuel are met by varying the height of the producer so as to permit of a

sufficient time of contact between the fuel and the blast to permit of a complete gasification. The producer may be connected with the engine in various ways, but in general one of the methods standardized in Figs. 8 and 9 will be found to be possible and cheapest.

The cost of these producers, their weights and dimensions are given in Table II., the dimensions referring to Fig. 7 and the horse-power rating referring to the engine which they will supply.

H.P. Size.	Speed	A	B	C	D	E	F	Height of Producer Room.	Cubic Feet Power House	Cubic Feet H.P.
75	170	15′ 6″	22′ 0″	13′ 0″	7′ 10″	7″	7″	15′ 6′	9,700	130
85	160	16 6	23 0	13 0	8 5½	7	7	16 0	10,800	127
100	155	17 0	24 0	15 0	8 9½	8	7	16 0	14,300	143
125	145	17 6	25 6	15 0	9 0½	8	7	16 0	13,300	106
150	135	18 6	27 0	18 0	9 6¼	9	7	16 6	16,300	110
175	130	20 0	28 6	18 0	10 5¼	12	8	16 6	17,900	101

From the preceding table the first cost of the engines, producers and buildings can be estimated. A suitable building can be provided at a cost of about 10 cents per cu. ft., which would bring the building cost between $10 and $14 per H.P. for both of the plant arrangements of Figs. 8 and 9. Producer foundations are so small as to be negligible in cost, but engine foundations can be put in for about 35 cents per cu. ft. so that the cost will lie between $3.50 and $4.50 per engine H.P. Starting equipment will include storage tanks, air pumps, motor or engine driven, gauges, valves and connections and will cost somewhere near $1.20 per H.P. The water supply should include a circulating pump and power to drive it, taking water from a nearby source and should be obtainable for $1.50 to $2.00 per H.P., and it need not be installed at all if a supply of water is available under pressure. If no water is available, or is scarce, wells must be sunk or cooling towers installed to permit of using water several times over with only 10 per cent. to 15 per cent. loss by evaporation, but this contingency is not here considered. Direct current electric generators will cost about $20 per K.W. of builder's rating at standard speed, but as the generator is designed for considerable overload the rated size in K.W. to couple with these gas engines is best determined by taking about

two thirds of the engine horse-power instead of the usual three fourths. Furthermore, the engine speeds are much lower than the rated dynamo speeds in the ratio 1 to 2 approximately, which

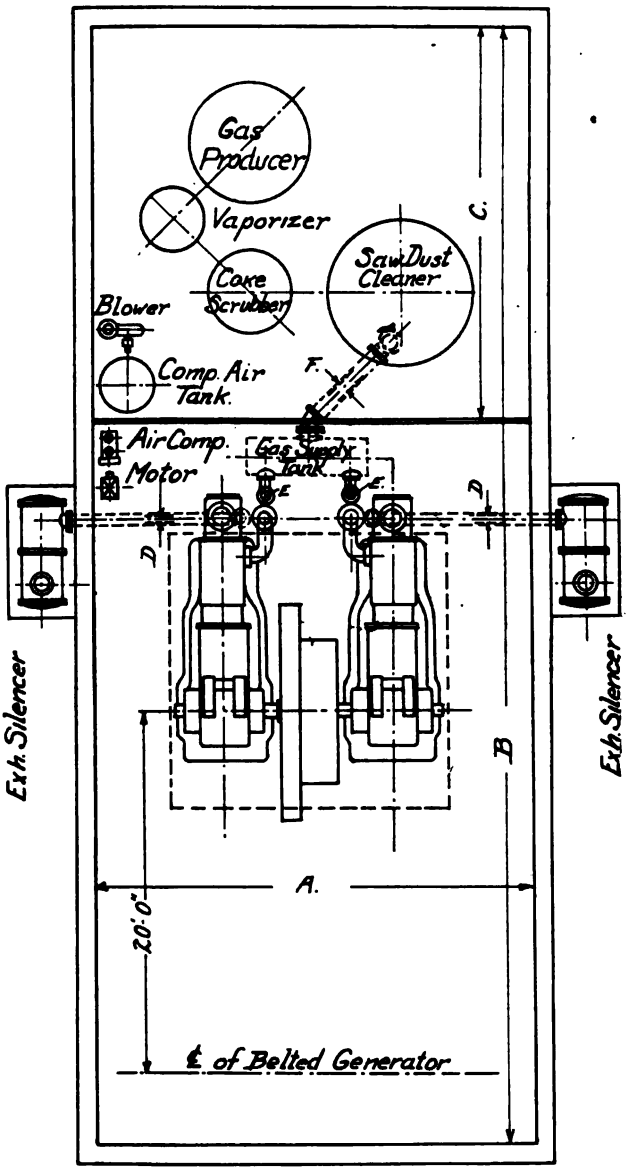


FIG. 9. Arrangement of single suction producer and twin engine for belted generators.

would bring the cost to about $40 per K.W. for direct connected units. For example, the 350 H.P. engine should have a generator of about 230 K.W. capacity at 130 R.P.M. The nearest machine of one of the prominent electrical manufacturers is a 250 K.W. at 125 R.P.M., which would cost about $8,000, or $32 per K.W. of manufacturer's rating or $23 per engine H.P. The switchboard and interior wiring including lighting of station may be taken at about $10 per engine H.P., making the electrical equipment cost

Size.	Speed.	A	B	C	D	E	F	Pulley 4,000 Ft. per Min.	Height of Producer Room.	Cubic Feet Power House.	Cubic Feet H.P.
2× 75	170	21′ 0″	59′ 0″	19′ 0″	7″	7″	8″	7′ 6″×14″	16′ 6″	20,400	136
2× 85	160	21 0	59 0	19 0	7	7	8	8 0 ×16	16 6	20,400	120
2×100	155	24 0	63 0	22 0	8	7	10	8 2 ×20	17 6	26,500	133
2×125	145	24 0	64 0	22 0	8	7	10	8 9 ×24	17 6	26,900	118
2×150	135	27 0	66 6	23 0	9	7	10	9 6 ×28			
2×175	130	27 0	68 0	23 0	12	8	10	9 9 ×34			

$33 per H.P. of engine rating for the direct connected units or $22 for the belt driven sets with twin engines. To cover small items like concrete floor, painting, plumbing, hoists and tools, a miscellaneous charge of $5 per H.P. is added to obtain a total cost per H.P. for four plants ranging from 75 H.P. to 250 H.P., two with single and two with twin engines in Table III.

The yearly fixed charges on this investment may be estimated as per Table IV. in which item No. 1 represents interest and depreciation or sinking fund charged at 12 per cent.; No. 2 material and labor for repairs and maintenance listed at 1.5 per cent., though practically nothing should be charged for the first and second years it is this item that heavy construction will assist in keeping low. Labor is figured at $90 per month for one man and $40 per month for a helper for the small plant and $100 and $50 for larger plants. The duties of the helper are to handle coal and ash and poke the producer and clean up; both men clean producer and two men are allowed to even the small plant to permit of immediate repairs which will keep repair cost low. Labor is made a fixed rather than an operating charge because the men must be kept on no matter what the load. Miscellaneous charges of 1.5 per cent. include superintendence, insurance, taxes, etc.

TABLE II.

De La Vergne Suction Producers.

Size, H.P.	75	100	125	150	175	200	250	300	350
Dimensions *a*	50	60	60	68	68	85	85	97	97
Dimensions *b*	24	33½	33½	33½	33½	46	46	—	—
Dimensions *c*	33½	46	46	46	46	59	59	59	59
Dimensions *d*	59½	73	73	84	84	101	101	119	119
Dimensions *f*	114⅜	120½	120½	144½	168½	144½	144½	168½	192½
Dimensions *l*	129⅜	136⅛	136⅛	138⅛	138⅛	147½	147½		
Dimensions *m*	64⅜	65⅜	63½	64⅞	65½	60⅛	60⅛		
Dimensions *n*	64⅜	77	77	79⅜	79⅜	99 5/16	99⅜		
Dimensions *o*	67⅜	80½	80½	86	86	101½	101½		
Dimensions *p*	40	49½	49½	53⅜	53⅜	67⅜	67⅜		
Dimensions *r*	50¼	59	59	59	59	72¾	72¾		
Dimensions *s*	7	7	7	7	8	10	10	10	10
Dimensions *x*	13′–0″	15′–0″	15′–0″	18′–0″	18′–0″	21′–0″	21′–0″	24′–0″	24′–0″
Dimensions *y*	15′–6″	16′–0″	16′–0″	16′–6″	16′–6″	17′–6″	17′–6″	18′–6″	18′–6″
Dimensions *z*	20′–0″	24′–0″	24′–0″	27′–0″	27′–0″	32′–0″	32′–0″	36′–0″	36′–0″
Sq. ft. enclosing rectangle	260	360	360	486	486	672	672	864	864
Sq. ft. per H.P.	3.5	3.6	2.9	3.3	2.8	3.4	2.7	2.9	2.5
Cu. ft. prism including head room	4030	5760	5760	80.20	820.20	80.20	11760	15980	15980
Cu. ft. per H.P.	54	57	45	54	46	58	47	53	45
Wt. lbs.	17200	22800	22800	31550	31550	37400	45900		
Lbs. per H.P.	230	223	180	210	180	180	150		
Cost per H.P.	$18.94	$18.85	$15.09	$15.90	$13.63	$14.00	$13.50		
Cost per lb.	8.3c.	8.5c.	8.3c.	7.6c.	7.5c.	7.8c.	7.4c.		

TABLE III.

FIRST COST OF ENGINE AND SUCTION PRODUCER.

Engine H.P.	75	150=2×75	175	250=2×125
Producer	$ 18.94	$ 15.90	$ 13.63	$13.50
Engine	52.00	45.70	42.60	39.90
Electrical Equipment	33.00	22.00	33.00	22.00
Foundation	4.70	3.47	4.48	3.26
Building	13.00	13.60	10.10	10.70
Piping	3.00	3.50	2.50	3.00
Starting Equipment	1.20	1.20	1.20	1.20
Water Supply	1.80	1.70	1.60	1.40
Miscellaneous	5.00	5.00	5.00	5.00
Total	$132.64	$112.07	$114.11	$99.96

TABLE IV.

FIXED CHARGES PER YEAR PER H.P. OF RATING.

	75	150	175	250
1. Interest and depreciation at 12%	$15.92	$12.50	$13.69	$12.00
2. Repairs and maintenance at 1.5%	1.99	1.68	1.71	1.50
3. Labor	20.80	12.00	10.30	7.20
4. Miscellaneous	1.99	1.68	1.71	1.50
5. Total yearly charge per H.P. of rating.	$40.70	$27.85	$27.41	$22.20
6. Total yearly charge in round numbers..	$3,052	$4,200	$4,800	$5,550

The preceding table shows that the fixed charge yearly is not in proportion with the rating of the plant so that the fixed charge cost per H.P. year or hour of output is an element that cannot be predicted with any certainty or formulated algebraically; it must be calculated for each special case.

In order to arrive at the total power cost there must be added to the above, the operating charges, which vary with the operating time and the consumption of raw materials per unit, and this involves the plant efficiency and its variation with load as the principal element. The full-load efficiency of units of this size is about the same for all and will correspond to about 13250 B.T.U. per hour per B.H.P. for the plant of 2,545/13,250 = 19.2 per cent. which is divided into 25 per cent. for the engine referred to brake horse-power or about 30 per cent. referred to indicated and 76 per cent. for the producer when all are in good adjustment. The proper adjustment of the engine and proper handling of the producer are very important and may affect fuel consumption much more than load, and because of this a good man must be employed as chief operator and he must have proper laborer assistance. This

plant efficiency will correspond to a consumption of small anthracite of 1.1 lb. yielding 12,600 B.T.U. per lb. as most of it does. For ordinary operating conditions with only one unit, as here assumed, the fuel consumption will be greater as the adjustments are not carefully attended to and as the load is decreased practically doubling at one fourth load. This latter is important in considering the effect of load factor because the engine might operate at full load for one fourth time and burn 1.1 lb. of anthracite per B.H.P. hour and have a load factor of 25 per cent., whereas with the same load factor due to one fourth load operation all the time the fuel consumption would be 2.2 lbs. per B.H.P. hour, or with the same load factor carrying half load for half time the fuel consumption would approximate 1.8 lbs. per B.H.P. hour. This coal costs in various parts of the country, excluding the mines, from $2.00 to $6.00 per ton and may at extremely distant points reach $10.00. On these figures the coal cost per H.P. hour can be estimated, but to each figure there is usually added about 15 per cent. for stand-by losses at starting when the plants shut down over night every day, as is usually the case with single unit installations, especially for factory service. The cost of coal per lb. is 2.00/2,000 = .10 cent at $2.00, .15 cent at $3.00, .20 cent at $4.00, .30 cent at $6.00 and .50 cent at $10.00 per ton of 2,000 lbs. From these and the values of load factors, engine load and fuel consumption with load, the following figures for coal cost per B.H.P. hours are determined. The lubricating oil consumption does not depend on the load but only on the number of hours of operation and somewhat though not very much on size. A single cylinder engine of 150 H.P. is usually found to use about one half pint of cylinder oil per hour and one and one half pints of bearing oil per hour, costing respectively 65 cents and 35 cents per gallon. The amount will be about the same for 125 H.P. and 175 H.P. and almost three fourths for 75 H.P. Twin engines may be assumed to use twice as much as single engines of the same cylinder size. This brings the cost of cylinder oil per hour for 150 H.P. engine to 4 cents and lubricating oil to 6.6 cents and for a 75 H.P. engine to 3 cents and 5 cents respectively. Other small items such as waste, paint, bolts, packing, cleaning material will be covered by adding to the total about 10 per cent., which will also allow a little lack of care in management. To the total of the operating charges, thus determined in Tables V., VI., VII., VIII., is to be added the total yearly cost divided by the horse-

Quarter		
2.2		
1.5 per cent.		
4.00	6.00	10.00
.440	.660	1.100
.066	.099	.165
8.0	8.0	8.0
.424	.424	.424
.930	1.183	1.689
1.023	1.291	1.858
82125		
3052		
3.720	3.720	3.720
4.743	5.011	5.578
1560		
1.900	1.900	1.900
2.923	3.191	3.758
1492		
1.820	1.820	1.820
1.61	1.75	2.07

.....Full.....						
.....I.I.....						
.....25 per cent.....						
)0	10.00	2.00	3.00	4.00	6.00	10.00
)60	1.100	.110	.165	.220	.330	.55
)99	.165	.016	.025	.033	.049	.08
	10.4	10.4	10.4	10.4	10.4	10.4
:36	.236	.059	.059	.059	.059	.05
)65	1.501	.185	.249	.312	.438	.69
)61	1.651	.204	.273	.343	.482	.76
.....383250.....						
.....4800.....						
180	2.480	1.240	1.240	1.240	1.240	1.24
541	4.131	1.444	1.513	1.583	1.722	2.00
.....1800.....						
140	1.140	.570	.570	.570	.570	.57
201	2.791	.774	.843	.913	1.052	1.33
.....3000.....						
540	1.540	.770	.770	.770	.770	.77
43	1.81	1.01	1.09	1.19	1.37	1.73

			Full			
			I.I			
			25 per cent			
0	10.00	2.00	3.00	4.00	6.00	10.
60	1.10	.110	.165	.220	.330	
99	.165	.016	.025	.033	.049	
	15	15	15	15	15	15
00	.400	.100	.100	.100	.100	
59	1.665	.226	.290	.353	.479	
75	1.832	.249	.319	.388	.527	
			328500			
			4100			
00	2.500	1.250	1.250	1.250	1.250	1
75	4.332	1.499	1.569	1.638	1.777	2
			1800			
80	1.080	.540	.540	.540	.540	
55	2.912	.789	.859	.928	1.067	1.
			2300			
20	1.420	.710	.710	.710	.710	
5	2.15	1.12	1.20	1.31	1.50	1.

ıarter				
2.2				
r cent.....				
4.00	6.00	10.00	2.00	
.440	.660	1.10	.110	
.066	.099	.165	.016	
5	15	15	15	
.240	.240	.240	.060	
.740	.999	1.515	.186	
.814	1.1	1.666	.205	
73750				
5550				
2.040	2.040	2.040	1.020	
2.854	3.140	3.706	1.224	
1800				
.660	.660	.660	.33(	
1.474	1.760	2.326	.53!	
3750				
1.380	1.380	1.380	.69(	
1.07	1.27	1.69	.78	

power hours generated to give the total cost of power per B.H.P. hour, as reported in line 16. As most power costs are reported for the operation only it is desirable that the labor item, here included under fixed yearly charges, be separated and added to the operating materials. The result is given in line 19, total operating cost per B.H.P. hour including labor and line 21, total fixed charges per B.H.P. hour excluding labor, which added together gives line 16, the total power cost per B.H.P. hour. The last line gives the ratio of these operating costs to the fixed charges and is useful in comparing with other installations and as showing the relative importance of fixed and operating costs.

These tables are extremely instructive and will bear some study for besides giving values for the cost of power they show all the elements entering into it, together with their relative importance. The total cost of power (No. 16) per B.H.P. hour increases with the cost of coal per ton, but by no means in direct proportion; thus, for 75 H.P. an increase of five times in the coal cost changes the total power cost as follows: total power cost between $1\frac{1}{2}$ times for half time full load as a maximum and $1\frac{1}{8}$ times for quarter time full load as a minimum. This shows the importance of coal cost by itself. The effect on operating cost (No. 19) is not very different as this is increased at the same time between $1\frac{3}{4}$ times to $1\frac{7}{8}$ times, a little more, which is explained by the relation of operating and fixed charges (No. 22). The same limits will apply to total cost for the larger engines, so that the cost of coal per ton has no relation to the size of engine so far as its effect on this total cost is concerned, but by reason of the difference in the ratio of operating to fixed charges the effect on operating cost will be different, lying between $1\frac{1}{2}$ and $2\frac{1}{2}$ times as the cost increases 5 times the cost of coal per ton.

The effect of increased size of engine is marked in its reduction of total power costs chiefly because the fixed charges are smaller per unit for the large ones. A similar reduction of operating cost is likewise the effect of increased size because oil and labor costs do not vary in proportion with size. Coal costs per H.P. hour are dependent only on cost per ton and on the individual load. The strongest factor in every case in fixing power costs is the load factor, especially where low load factor is the result of low individual engine load as will appear from all the tables.

The power costs for these plants are extremely low and cannot

be met by steam plants of the same size operating under the same conditions except where coal is extremely cheap. Operating power costs like these varying from .73 cent to 1.29 cents per H.P. hour with coal at $2 per ton and on 50 per cent. load factor for 75 H.P. are quite impossible with steam, and even accounting for a lower fixed charge the difference cannot be made up because the operating costs lie between 1.6 and 2.8 times the fixed charges for these conditions. For the same conditions the total operating costs for the other sizes are summarized in Table IX.:

TABLE IX.

OPERATING COST OF POWER, CENTS PER H.P. HOUR AT 50 PER CENT. LOAD FACTOR.

ENGINES.	Coal at $2.00.	Coal at $10.00.
75 H.P. single	$ .75	$1.29
150 H.P. twin	.52	1.08
175 H.P. single	.44	1.00
250 H.P. twin	.37	.92

These costs are just about commensurate with those of the largest steam plants of over 50,000 H.P., such as operate the electric railways and central stations of the City of New York and are absolutely unheard of in steam practice. Whether in any particular size a lower installation cost for a steam plant accompanied by a higher fuel consumption will make it a competitor can be roughly judged by the tables and ratios giving the relative importance of the various items but in small and medium sizes such as are here considered as typical in size of the average factory or small town plant, it will be found that the gas plant is superior as capable of producing power at a total cost varying from one half to one fifth as much as the steam plant.

CHEMISTRY AND THE CONSERVATION OF OUR FORESTS AND MINERALS.*

By MARSTON TAYLOR BOGERT.

At the first conference on Conservation of our Natural Resources held at the White House, May 13–15, 1908, a most admirable Declaration of Principles was unanimously adopted by the assembled governors.

It is given here in full, and should be read carefully by every patriotic citizen of the United States: —

"We, the governors of the states and territories of the United States of America in conference assembled, do hereby declare the conviction that the great prosperity of our country rests upon the abundant resources of the land chosen by our forefathers for their homes, and where they laid the foundation of this great nation.

We look upon these resources as a heritage to be made use of in establishing and promoting the comfort, prosperity, and happiness of the American people, but not to be wasted, deteriorated, or needlessly destroyed.

We agree that our country's future is involved in this; that the great natural resources supply the material basis upon which our civilization must continue to depend, and upon which the perpetuity of the nation itself rests.

We agree, in the light of the facts brought to our knowledge and from information received from sources which we cannot doubt, that this material basis is threatened with exhaustion. Even as each succeeding generation from the birth of the nation has performed its part in promoting the progress and development of the republic, so do we in this generation recognize it as a high duty to perform our part; and this duty in large degree lies in the adoption of measures for the conservation of the natural wealth of the country.

We declare our firm conviction that this conservation of our natural resources is a subject of transcendent importance which should engage unremittingly the attention of the nation, the states, and the

* Taken, in part, from the author's presidential address on "The Function of Chemistry in the Conservation of our Natural Resources" before the American Chemical Society at Baltimore, December 30, 1908, *Jour. Am. Chem. Soc.*, 31, 125–154.

people in earnest coöperation. These natural resources include the land on which we live and which yields our food; the living waters which fertilize the soil, supply power, and form great avenues of commerce; the forests which yield the material for our homes, prevent erosion of the soil, and conserve the navigation and other uses of the streams; and the minerals which form the basis of our industrial life, and supply us with heat, light, and power.

We agree that the land should be so used that erosion and soil wash shall cease; and that there should be reclamation of arid and semiarid regions by means of irrigation, and of swamp and overflowed regions by means of drainage; that the waters should be so conserved and used as to promote navigation, to enable the arid regions to be reclaimed by irrigation, and to develop power in the interests of the people; that the forests which regulate our rivers, support our industries, and promote the fertility and productiveness of the soil should be preserved and perpetuated; that the minerals found so abundantly beneath the surface should be so used as to prolong their utility; that the beauty, healthfulness, and habitability of our country should be preserved and increased; that sources of national wealth exist for the benefit of the people, and that monopoly thereof should not be tolerated.

We commend the wise forethought of the President in sounding the note of warning as to the waste and exhaustion of the natural resources of the country, and signify our high appreciation of his action in calling this conference to consider the same and to seek remedies therefor through coöperation of the nation and the states.

We agree that this coöperation should find expression in suitable action by the Congress within the limits of and coextensive with the national jurisdiction of the subject, and, complementary thereto, by the legislatures of the several states within the limits of and coextensive with their jurisdiction.

We declare the conviction that in the use of the national resources our independent states are interdependent and bound together by ties of mutual benefits, responsibilities, and duties.

We agree in the wisdom of future conferences between the President, members of Congress, and the govenors of states on the conservation of our natural resources with a view of continued coöperation and action on the lines suggested; and to this end we advise that from time to time, as in his judgment may seem wise, the President call the governors of states and members of Congress and others into conference.

We agree that further action is advisable to ascertain the present condition of our natural resources and to promote the conservation of the same; and to that end we recommend the appointment by each state of a commission on the conservation of natural resources to coöperate with each other and with any similar commission of the federal government.

We urge the continuation and extension of forest policies adapted to secure the husbanding and renewal of our diminishing timber supply, the prevention of soil erosion, the protection of headwaters, and the maintenance of the purity and navigability of our streams. We recognize that the private ownership of forest lands entails responsibilities in the interests of all the people, and we favor the enactment of laws looking to the protection and replacement of privately owned forests.

We recognize in our waters a most valuable asset of the people of the United States, and recommend the enactment of laws looking to the conservation of water resources for irrigation, water supply, power, and navigation, to the end that navigable and source streams may be brought under complete control and fully utilized for every purpose. We especially urge on the federal Congress the immediate adoption of a wise, active, and thorough waterway policy, providing for the prompt improvement of our streams and the conservation of their watersheds required for the uses of commerce and the protection of the interests of our people.

We recommend the enactment of laws looking to the prevention of waste in the mining and extraction of coal, oil, gas, and other minerals with a view to their wise conservation for the use of the people, and to the protection of human life in the mines.

Let us conserve the foundations of our prosperity."

President Roosevelt has well said that "the life of the nation depends absolutely on the material resources, which have already made the nation great."

This call to service comes to the chemist both because he is a patriotic American deeply interested in everything which concerns the welfare of his country, and because his expert knowledge of an important branch of science will enable him to assist in the solution of many of the problems arising in connection with the economic utilization of our natural resources. The dignity and honor accorded a profession depend largely and properly upon the extent to which it ministers to the needs of the community, and

such an appeal as the above to the thousands of chemists in the United States will not be in vain.

In considering the matter, the first thing needed is a clear understanding of the nature of the problem so that the chemist can see for himself where he can be of service. I shall, consequently, endeavor to state the case somewhat in detail, pointing out incidentally where chemistry is likely to be or has already been helpful. I have no apology to offer if much of the material presented appears to touch chemistry but remotely or not at all. The important thing is that the issues, in their larger aspects at least, should be before us all, for the subject is greater than any one science.

It would be strange indeed if the science which deals with the ultimate constituents of our material universe, their combinations and transformations, could not offer any assistance in the solution of the problem as to how our natural resources can be conserved. It is chemistry that has determined the composition of those materials which make up the earth upon which we live, the atmosphere which surrounds it, and the heavenly bodies beyond. Chemistry studies the properties of the elements and their various compounds and upon these fundamental data our industries rest.

The transformation of the raw material into the finished product consists usually either in changing its external form, as in wood and metal working, weaving, and the like, or there is involved a chemical change, as in metallurgy, fermentation industries, the manufacture of glass, soap, cement, chemicals, etc. Practically all of our manufacturing processes are therefore primarily either mechanical or chemical. In the production of a metal from its ores, or of indigo from coal tar, it is chemistry that points the way, and the more complex the problem the greater the dependence upon this science. In devising new processes and in the discovery of new and useful products, chemistry is again the pathfinder. The community is apt to overlook the extent and diversity of the services rendered by the chemist because of the quiet and unobtrusive way in which the work is carried out.

The measure of a country's appreciation of the value of chemistry in its material development and the extent to which it utilizes this science in its industries, generally measure quite accurately the industrial progress and prosperity of that country. In no other country in the world has the value of chemistry to industry been so

thoroughly understood and appreciated as in Germany, and in no other country of similar size and natural endowment have such remarkable advances in industrial development been recorded, and this, too, with steadily increasing economy in the utilization of the natural resources.

That our government realizes the importance of chemistry seems evident from the fact that six of our nine federal departments already maintain chemical laboratories where they handle both their own chemical work and that of the departments of state, justice, and post office, which as yet have no chemical laboratories,

The question confronting us at the outset is: What are the material resources upon which the existence of the human race and its advancement in civilization depend?

The following classification will perhaps suffice to answer this question: A, extra-terrestrial resources (the sun); B, terrestrial resources: (I.) atmosphere (protection from pollution), (II.) water (including rainfall, purity, water power, navigation and transportation, and irrigation), (III.) land (including amount available, soil, agriculture, stock-raising, forests, and minerals).

The present paper, as its title states, deals only with our forest and mineral resources.

FORESTS.

Our total annual consumption of wood, including that used for fuel (100,000,000 cords), is at least one hundred billion board feet, of which forty billion is for lumber. As the total amount of our standing merchantable timber is estimated by the Forest Service, as less than fourteen hundred billion board feet, the end of our forests is indicated in twenty to thirty years, as forest fires and other destructive agencies seem quite certain to fully offset new growth. The Secretary of Agriculture has said that a continuation of the present tendencies in the southern Appalachians will obliterate its commercial forests within the next sixteen years. We are consuming our forests at the rate of about forty-five square miles per day.

The chief uses for our timber are lumber, lath, shingles, fuel railroad ties, paper pulp, cooperage stock, mine timbers, tan bark distillation, veneer, posts and poles. Secretary Will, of the American Forestry Association, has calculated that we consume each year enough lumber to floor the entire state of Delaware, enough lath to fill a train reaching from Chicago to Memphis, enough

cooperage stock to build a rick four feet wide and four feet high extending from New York city to Colorado, enough firewood to make a one mile cube, and enough railroad ties to build a railroad around the glode with a sidetrack across the Atlantic, while our annual wood bill exceeds one billion dollars.

Of the above items, lumber is by far the most important. As just mentioned, our annual cut is forty billion board feet or five hundred feet per capita, against 60 feet per capita in Europe. Lumber is our fourth greatest industry, being exceeded only by food products, manufactures, and textiles. It pays annually about $100,000,000 in wages, operates 33,000 mills, and gives a living to about 2,000,000 people.

In 1905 Mr. J. T. Richards, Chief Engineer of Maintenance of Way, Pennsylvania R. R. system, estimated our annual consumption of railroad ties at ninety to one hundred and ten million, equivalent to over three billion board feet, or nearly half a million acres of forest, and the total number then in use in the United States as six hundred and twenty million. As railroad ties then averaged about 50 cents apiece, this meant an annual charge of $50,000,000 and a total investment of over $300,000,000. Our consumption now is 118,000,000 ties.

In 1906, our consumption of shingles was over two billion board feet.

In 1907, about four million cords of wood, or two billion board feet, valued at about $30,000,000, was converted into paper pulp. One fourth of this amount, however, was imported. Sixty-eight per cent. of the wood used was spruce. In three months one of our New York daily newspapers would consume a forest as large as Central Park (843 acres), while a single one of its Sunday issues would require 15 acres of forest.

Dr. David T. Day, of the U. S. Geological Survey, reports that in 1905 it took about a cubic foot of timber for every ton of anthracite mined, say seventy million cubic feet annually; for bituminous coal rather less per ton, say 250 million cubic feet per annum; for iron, about twenty million cubic feet; and for precious metals, seventy-five million cubic feet — a grand total of four hundred million cubic feet, or about five billion board feet. Our anthracite mines alone require annually 150,000 acres of forest, and in the famous Copper Queen mine 25 feet of Oregon pine takes the place of every ton of ore extracted.

Our total consumption of tan bark in 1906 was nearly one and a half million cords, worth about $13,000,000; besides 660,000 barrels of extract (half of which was imported quebracho), worth nearly $9,000,000. Practically all of the bark used was hemlock or oak, and the chief native wood used for extract was chestnut.

In 1904, we produced over thirty million gallons of turpentine and three and a half million barrels of rosin.

In 1906, over a million cords of hard wood, chiefly maple, beech, and birch, were distilled, and products obtained valued at $8,000,000. We use annually over a billion posts, poles, and fence rails, one and a half billion staves, over one hundred and thirty-three million sets of heading, and nearly five hundred million barrel hoops. Furniture consumed five hundred and eighty million feet of lumber in 1905, while matches require annually sixty million feet, or ten thousand acres. A single machine in one of the Detroit factories turns out seven million two hundred thousand matches a day. Toothpicks and excelsior each consume annually about 10,000 acres of forest.

The waste of our timber resources is due to fire, careless logging, wasteful mill operations, wasteful use of wood, turpentining, overproduction, unjust methods of taxing forest lands, the abandoning of non-productive wooded areas or the clearing of them for agricultural purposes, and the ravages of fungi, parasites, insects, and animals. In all, probably seventy-five per cent. of our forest products is generally wasted. Of every one thousand feet of lumber which stood in the forest but 320 feet are used.

Fire is much the most destructive agent to our forests. The loss to the forest from this single cause is colossal, and if we add the loss of buildings burned in our cities and villages, it becomes still more so. We have heard much of panic and business disaster during the past year, but it is quite certain that when we come to cast up the account it will be found that the terrible forest fires of last summer, in their far-reaching injury to the present and immediate future of our country, will greatly exceed the losses incident to the recent panic. The direct damage from last summer's forest fires has been estimated at approximately $100,000,000, but the injury to water-sheds and all the damage which follows deforestation cannot easily be computed. Between 1877 and 1907, forest fires caused a loss of 1,956 lives, besides millions of acres of forests. So far, 296 deaths have been reported in 1908 as due to this cause,

while the amount of forest obliterated has not yet been ascertained. The annual loss of new growth due to the destruction of seedlings and young trees by fire has been estimated at $90,000,000. The saddest feature of it is that almost all of this huge loss was directly avoidable by ordinary care and intelligence. Forest fires could almost wholly be avoided at a cost one fifth of the value of the timber annually destroyed.

In the last five years, the total fire losses in buildings in the United States amounted to a billion and a quarter dollars. This was due mainly to the combustibility of the timber construction employed and might have been largely prevented by the use of suitable chemical fire-proofing compounds. In 1906, we spent $650,000,000 in building operations and the total cost of our fires was $500,000,000 and 6,000 human lives. In all the United States there are about twelve million buildings, in only about 8,000 of which has any serious attempt been made at fire prevention. The latest government reports show that in forty-nine of our leading cities, fifty-nine per cent. of the new buildings were of wood. If we should include the smaller towns and villages this figure would, of course, be much larger.

As to wasteful logging operations, twenty per cent. of the log (the upper part) is now left in the woods to rot or burn, because it does not pay to haul it to market at present prices. At the current rate of consumption of yellow pine, this is equivalent to a waste of three hundred thousand acres of forest annually. Of all the yellow pine cut in 1907, about half of it, or eight million cords, was wasted. The slab residue from our lumber cut is estimated at fourteen million cords per annum, of which about six million cords is sold for fuel, three and a half million is used by the mills as fuel, and the remaining four and a half million is consumed in their refuse burners.

The damage inflicted by caterpillars, fungi, and animals constitutes another drain upon our forests and shade trees. The ravages of the gypsy and browntail moths, of the elm worm and of the pine blight are familiar to most of us. The drought of the past summer resulted in a plague of caterpillars in many sections of our country and, aside from the havoc wrought in farm crops, thousands of acres of forests were stripped of every green leaf and left as bare as in winter. Previous to this year, the Forest Service has estimated the average annual loss in the East from these causes

at fifteen to twenty million dollars. But now the chestnut blight has appeared and the total annihilation of all these beautiful trees in the East is threatened. Already the damage is estimated at ten million dollars, and no way has yet been found to cope successfully with it. It is to be hoped that the chemist can help here. It was a chemist — Pasteur — who, by his investigations of the diseases of the silkworm, saved the silk industry of France, and by his study of the "diseases of wine" saved that industry from heavy loss.

The only business that uses the forests without much waste is the tannin extract industry, which sweeps the chestnut and oak forests almost clean, taking young as well as mature trees.

Can the chemist do anything to conserve our timber supply and postpone the exhaustion of our forests? In spite of the fact that *for the present* he must plead guilty to using the forests for the production of paper, distillation products, tannin and naval stores, I say without fear of successful contradiction that he is easily one of the chief conservers of our forests.

In the first place, chemistry has put into the hands of the builder non-combustible materials, such as iron and steel, cement and concrete, brick, plaster, terra cotta, tiles, porcelain, pottery, stoneware, and all kinds of metallic furnishings and finishings, thereby directly reducing the demand for lumber. The production of cement in 1890 was 335,000 barrels; in 1907 it was 52,000,000 barrels, worth $56,000,000. The quality of the cement, further, depends primarily upon the accurate analysis of its ingredients. The modern methods of reinforcing concrete admit also of slender construction. The plasticity of the concrete when first applied and its monolithic character when set are great advantages, besides which, in contradistinction to wood construction, it grows stronger as it grows older. If, nevertheless, the builder finds it necessary to use wood or other combustible materials, the chemist shows him how to treat these substances so as to render them fireproof. A small fraction of the amount annually lost in fires would probably suffice to fireproof all our wooden construction. If fireproofing is neglected, the wood must at least be protected from weathering and decay, and for this purpose the chemist provides paints, varnishes, etc. Our annual consumption of paint amounts to one gallon for every man, woman and child in the United States. In other cases, the life of the wood is prolonged by creosoting, or

treatment with similar preservatives, which protect it from weather and water, from attacks of marine borers, of molds, fungi, etc. The application of preservatives also permits the use of inferior woods, for it has been found that the latter when creosoted, outlast the finest quality of untreated timber.

In fighting the inroads of caterpillars, insects, etc., the chemist is called upon to supply the necessary insecticides, fungicides, etc.

To offset the damage caused the forests by the paper pulp industry, the chemist is busily searching for some other cheap source of cellulose, particularly in such waste products as sawmill refuse, corn stalks, cotton stalks, bagasse, the straw from various grains, etc.; and meanwhile, has pointed out that other trees, for example, the white fir of the Pacific coast, can be used instead of the fast disappearing spruce.

For acetic acid, wood alcohol and acetone, we must still call upon the forests, but formic acid from generator gas is already proving a serious rival to acetic acid for certain uses.

In the matter of tanning the chemist has already partly repaid his debt to the forests by the discovery of chrome tannage for upper leathers, and the action of formaldehyde upon albuminoid substances. The discovery of a satisfactory mineral tannage for heavy hides will square the account. Tannin is also being recovered from various waste products. In 1906, $15,000 worth of tannin extract was made in Florida from palmetto roots.

Thanks to the labors of a distinguished southern chemist, Professor Herty, less dangerous and more scientific methods of turpentining are gradually being introduced in the South.

The chemist also helps by showing how valuable by-products may be obtained from what would otherwise be wasted. Thus, turpentine and rosin may be recovered from pine sawdust and the residue used for pulp, or sawdust may be converted into a waterproof artificial wood by treatment with glue and bichromate. Formerly sawdust was also used as a source of oxalic acid, but the chemist has found a cheaper way of making it from the CO of furnace gas.

According to our consular reports, a factory has recently been erected at Grossalmerode, Germany, for the manufacture of glass telegraph poles.

Formerly all alkali for soap manufacture was obtained from wood ashes. If we still had to depend upon wood for all the alkali

we used the drain upon our forests would be a heavy one, but the chemist has shown how alkali can be obtained by the electrolysis of salt, and there is enough salt in our ocean, according to Dr. F. W. Clarke, to cover the entire United States a mile deep, or, according to Professor Joly, the entire globe to the depth of 112 feet, so we are in no immediate danger of a scarcity of alkali.

That the Forest Service appreciates the helpfulness of chemistry is evidenced by its operation of a chemical laboratory in connection with its work.

President Roosevelt has said that "The forest problem is in many ways the most vital internal problem before the American public to-day." The importance of the forests arises not solely from their being the source of our timber, but, still more important, because of their bearing upon our water supply. In forest cover, not only is erosion impossible, but the rains of summer evaporate more slowly, the snows of winter melt less rapidly, the run-off is more gradual and regular, floods cease, and the streams become available as sources of water-power.

Growing scarcity of timber means a steadily rising price for it and a correspondingly increased burden upon individuals and industries using it. With the failure of the forests, the lumber business, our fourth greatest industry, will cease; mining will become more expensive and the price of coal, iron, etc., will rise. High rates for coal and iron will affect the railroads. With raw materials and transportation higher, manufactured articles of all kinds will be dearer. Agriculture will be affected not only by the higher cost of the necessary tools, but also by alternate devastating floods and drought, and the absence of protection from high winds. The last of our once noble army of game will disappear with the disappearance of their homes — the forests. Reduction of the summer stream-flow will raise its temperature to a point where fish life may no longer be possible. An important climate-tempering factor will be missing. There will no longer be the cool and bracing air of the woods for the restoration of lost health and strength, nor the peace of the deep forests where, as Thoreau so beautifully expresses it, "Nature seems too happy to make a noise." As Mr. Pinchot, our chief forester, so truly says, "When the forests fail, every man, woman and child in the United States will feel the pinch."

The terrible results of total deforestation are before us in many

Oriental countries. Babylon and Antioch, Tyre and Sidon, as well as one third of China, have been ruined by deforestation. One thousand years before Christ the forests of Lebanon were famous throughout the world, and Tyre and Sidon were great lumber markets. Solomon had 80,000 lumbermen at work there cutting timber for the Temple. The region about Jerusalem was fertile and it was no exaggeration then to call it "a land flowing with milk and honey." Its forests have vanished and to-day it is barren and desolate. As Mr. R. A. Long says: "The rain-bearing clouds still float above the mountains of Syria, but they pass on over the bare and heated rocks, and the brooks and small streams of Palestine no longer exist." Mesopotamia, the traditional site of the Garden of Eden, must have been in ancient times one of the most beautiful spots in the world. Herodotus says that the culture of the grape could not succeed there on account of excessive moisture. To-day it is a sterile, treeless waste, and the Euphrates River, once the source of an abundant water supply, is now largely swallowed up in the sands of the desert before it reaches the Persian Gulf.

It may be assumed that as all this happened centuries ago, there is no immediate cause for worry. We should not be deceived on that score, for the effects of extensive deforestation are not long in appearing. Hough, in his "Elements of Forestry," says: "The Khanate of Bucharia presents a striking example of the consequences brought upon a country by clearings. Within a period of thirty years this was one of the most fertile regions of Central Asia, a country which, when well wooded and watered, was a terrestrial paradise. But within the last twenty-five years a mania for clearing has seized upon its inhabitants and all the great forests have been cut away, and the little that remained was ravaged by fire during a civil war. The consequence was not long in following and has transformed the country into a kind of arid desert. The water courses have dried up and the irrigating canals are empty. The moving sands of the desert, being no longer restrained by barriers of forests, are every day gaining upon the land, and will finish by transforming it into a desert as desolate as the solitudes that separate it from Khiva."

The forest problem has been solved in Europe, why not here? Germany's forest is to-day three hundred per cent. better than it was seventy years ago, the yield per acre is worth seven-fold what

it was, and the improvement is steadily advancing. With proper management, our forests can be made to yield four times what they do now.

Minerals.

Mining and Minerals in General.— In the first place, let it be kept clearly in mind that metallurgy is a branch of applied chemistry, being founded upon chemistry and engineering.

The total value of our mineral products in 1907 was over two billion dollars, and of our manufactures probably over seventeen billion dollars. The value of our mineral products is now four times what it was twenty years ago. In the past fifty years we have taken out far more of the mineral wealth of the earth than in the 350 years preceding. John Hays Hammond says that "The culmination of our mining industry is to be reckoned in decades, and its declension, if not practically its economic exhaustion, in generations, not in centuries." In general, it may be said that the seriousness of our mineral problem lies in the fact that these are resources which cannot be renewed. It may be urged that, as matter is indestructible, metals once won from their ores should not waste but accumulate, and this, no doubt, is partly true. It does not apply, however, to our fuels, for when carbon is once burned to CO_2 it is no longer available as fuel until by the slow processes of vegetable life, some of it is fixed in plants and gradually reduced through peat to coal again. Six times as much of our carbon is now locked up in mineral carbonates unavailable for fuel as there is in the form of coal.

The life of our mineral resources may be prolonged by the discovery of new supplies or satisfactory substitutes, by avoiding wastes in mining and extracting ores and the discovery of methods which will render low-grade or other ores available, by a more complete utilization of the latent possibilities of the ore including the recovery of all by-products, and by preventing loss of life and property through fires and explosions.

The chemist is helping in many of these lines. It is to him that we must usually turn for the production of satisfactory substitutes, for devising new processes, and for the utilization of by-products and wastes. It was the pioneer investigations of Bunsen and De Faur which pointed the way for the use of furnace gases in most of those directions in which they are now employed.

In smelting operations, the chemist must analyze the raw mate-

rials — ore, coke, limestone, etc., the intermediate products — the pig-iron if steel is to be made — and the final products, including the furnace gases and slags.

Without the explosives of the chemist, modern mining, as well as many great engineering works, would be impossible. After the precious metals have been extracted, it is powder which stands guard over them, as it does over all the accumlated wealth and property of this and other nations. On the other hand, a chemist, Sir Humphry Davy, by his invention of the safety lamp, has done more than any one else to protect the miner *from* explosions. It is worth noting that the authorities did not appeal to a chemist until all suggested engineering methods had proven powerless to avert the terrible "firing" of the mines. The new sodium dioxide compound "oxone" may prove of value in mine accidents, for it absorbs CO_2 with liberation of oxygen. The oxygen upon which rescuers now depend is also the result of the skill of the chemist.

In 1907, the total value of our fuels, including by-products, was over one billion dollars, divided as follows: coal, $615,000,000; coke, $112,000,000; petroleum, $120,000,000; natural gas, $53,000,000; artificial gas, $126,000,000, and coke by-products $7,000,000, or one billion thirty-three million dollars in all.

Excluding carbon present in carbonates, which is not available for fuel, the remaining carbon in our lithosphere, mainly coal, amounts, according to Clarke, to only 0.03 per cent., or 1/150th the amount of our iron. We are therefore much more likely to discover new mines of iron than of coal. Further than this, the development of other metals and alloys, and the use of concrete, will operate to reduce the drain upon our iron mines, but the case of our fuels seems much more serious. The likelihood of our discovering any satisfactory substitute for carbon as a fuel appears remote indeed. We must therefore reduce the demands upon our fuel supply, and this can be most effectively accomplished by the development of our water-power, as already pointed out. Dr. I. C. White, state geologist of West Virginia, puts it none too forcibly when he says: "Just as sure as the sun shines, and the sum of two and two is four, unless this insane riot of destruction and waste of our fuel resources which has characterized the past century shall be speedily ended, our industrial power and supremacy will, after a meteorlike existence, revert before the close of the present century to those nations that conserve and prize at their proper value their priceless treasures of carbon."

Natural Gas.— In heating value, the total original stock of natural gas probably rivaled or even excelled our total coal deposits. According to Dr. White, some individual wells have produced gas at the rate of 70,000,000 cu. ft. daily, equal in heating value to 70,000 bushels of coal, or to nearly 12,000 barrels of oil.

Natural gas is the ideal fuel. Wood and coal must be converted into gas before they burn, but here is a rich fuel already in the gaseous state and stored under such pressure that not only will it transport itself through suitable pipe lines to great distances, but in some instances this pressure is sufficient to drive engines without burning the gas at all. In tests conducted at Pittsburg to determine the relative heating value of natural gas and of the best coal, the gas gave 83.4 per cent. of its theoretical efficiency, while the coal gave but 60.9 per cent. And yet it is estimated that at least one billion cubic feet of this incomparable fuel, equivalent in heating value to approximately one million bushels of coal, is being wasted daily. Dr. White states that from a single well in eastern Kentucky gas streamed for twenty years, with no attempt to check or utilize it, the total value of which was three million dollars.

At the present rate, our natural gas will probably be exhausted by the middle of the century. The value of the natural gas produced in 1907 was $53,000,000. In 1906, four hundred billion cubic feet of gas, equivalent to nine million tons, was produced. Natural gas is used to some extent for illumination, by enriching it or burning it in Welsbachs.

Petroleum.— According to Dr. David T. Day, of the U. S. Geological Survey, the total production of petroleum in the United States in 1907 was approximately one hundred and sixty-six million barrels, valued at $120,000,000, or forty million barrels more than in 1906, this increase being greater than the total annual production for any year previous to 1889.

Some oils are used practically crude for lubrication or burning. As a fuel for vessels, petroleum has many advantages, and the British Navy has been conducting tests with a view to using it on many of their ships. Most petroleums, however, are subjected to careful rectification and chemical purification. At one time the waste in the oil business was enormous, as only the kerosene was saved. Now, with the exception of occasional fires and the relatively small amount sprayed into the air with escaping natural gas,

and the seepage from earth-pits used for storage of petroleum in certain sections of the country, the loss is very much less, for chemistry has not only shown how a greater yield of kerosene may be obtained, but also how all the by-products — gas, gasolene, naphtha, lubricating oils, paraffin, vaseline, and coke — may be saved with considerable financial profit. Certain of these distillates are used for the production of high candle-power illumination, as in the Pintsch and Blau gas processes.

The rapid growth in the use of gasolene for engines has developed an enormous demand for this petroleum fraction. The most promising substitutes for gasolene appear to be industrial alcohol and the benzene from by-product coke ovens. The former of these, although giving a much higher efficiency as a fuel, is still too expensive to compete with gasolene except in special cases. The latter, as our number of by-product coke ovens increases, is likely to play a more and more prominent part in this field.

According to the U. S. Geological Survey, the known supplies of petroleum cannot be expected to last much beyond the middle of the present century.

Coal. — Our total original stock of coal has been estimated at two thousand billion tons, of which we have used to date about seven billion and wasted three billion. The volume of our coal has been computed as equivalent to an eight-mile cube. Our production in 1907 was three hundred and ninety-five million tons of bituminous, worth $451,000,000, and seventy-six million tons of anthracite, worth $164,000,000, or a total of four hundred and seventy-one million tons, valued at $615,000,000. This is over 37 per cent. of the world's production, and is equivalent to five tons per capita. Dr. Goss has calculated that the total weight of coal produced in 1907, if in the form of market-size bituminous coal, would make a windrow of triangular cross-section, 46 ft. wide and 32 ft. high, extending from New York City past San Francisco and 200 miles out into the Pacific Ocean.

At the present rate of increase, one eighth of our total supply will have been consumed by 1937. All of our anthracite will be exhausted in 60 to 70 years, while our bituminous coal may last ten times as long. To quote once more from Mr. James J. Hill: "When fuel and iron become scarce and high-priced civilization, so far as we can now foresee, will suffer as man would suffer by the gradual withdrawal of the air he breathes." Long before final

exhaustion, it will be necessary to carry the workings deeper, increasing the difficulty of mining and the danger to the miner, and to use lower-grade material, while the price to the consumer will necessarily steadily rise. Already Great Britain's industries have felt the check from similar causes, as shown in her higher cost of production. In 1907, 3,125 people were killed and 5,316 wounded in coal-mining operations in this country. That means one human life for every 145,000 tons of coal mined, or five deaths out of every 1,000 employees, a death-rate four times that of Europe.

The greatest waste of our coal supply is in our imperfect processes for rendering available its latent energy. In the average power plant not over ten per cent. of the potential energy of the coal is utilized. About one quarter of our total coal consumption is in locomotives, and the loss due to boiler scale is probably at least 15,000,000 tons. The advent of the gas engine and producer gas has marked a long step in advance, for not only can the percentage of coal energy utilized be raised to 18 or more, but, what is even more important, low-grade coals, such as lignites and some peats become available. On the other hand, gas producers do not work very satisfactorily with bituminous coals, particularly those of the coking variety. Using small anthracite, producers will consume from one to one and a half pounds of coal per horse-power hour, while steam boiler plants require 2–3 pounds for large plants, and 4–8 pounds in very small plants. In plants of 300 H.P. or less, the same coal will generally give about 2½ times as much power in a gas engine as when burned under a boiler. In large plants (20,000 H.P. and over), the saving in fuel by the gas engine is largely offset by its greater cost of installation and maintenance. With high load factor (as is the case in most electrochemical factories), the conditions are most favorable for the gas engine. If we could harness all of the potential energy of the coal, our supply of fuel might be considered more nearly inexhaustible. Briquetting of fines also reduces waste, and it has been found that good briquettes make a hotter fire than ordinary lump coal, and that there are no cinders thrown and no smoke if properly fired.

With the exception of a few narrow strips in the West, there are no first-class coking coals known in the United States outside of the Appalachian Basin. Of the one hundred thousand coke ovens of the United States, thirty-five thousand are practically within

sight of Pittsburg, and they are consuming these splendid coking coals at such a rate that Dr. White asserts that by the beginning of the next century there will probably be no coal within one hundred miles of Pittsburg.

In 1907, over forty million tons of coke, valued at nearly $112,000,000, were produced from about sixty-two million tons of coal. Only five and a half million tons of this, or less than 14 per cent., were obtained in by-product ovens. About fifty-four and a half million tons of coal were coked in beehive ovens. This involved a waste of one hundred and forty-eight billion cubic feet of gas, worth $22,000,000; four hundred and fifty thousand tons of ammonium sulphate, worth a similar amount; and nearly four hundred million gallons of tar, worth $9,000,000. The gases evolved in coking ovens have high calorific power. Dantin estimates that in modern ovens only 65 per cent. of this is necessary to effect the carbonization. The remaining 35 per cent. amounts to about 3,700 cu. ft. of gas, equivalent to 420,000 calories, per ton of coke produced. As a gas engine of one thousand kilowatt power absorbs about 3,600 calories per kilowatt, the power wasted in beehive coking amounts to over four billion kilowatts or about three billion horse-power. We are therefore wasting enough power to establish a great manufacturing center, enough ammonium sulphate to fertilize thousands of acres, enough creosote to preserve our timber, and enough pitch and tar to roof our houses and briquette our slack and waste coal.

Lignites have been found to give not only an excellent yield of gas, but also tar, oils, paraffin, and other valuable by-products. It has recently been claimed that one ton of dried peat can be made to yield one hundred and sixty-two liters of pure alcohol and about 66 pounds of pure ammonium sulphate.

In 1907, four million tons of coal were consumed in the production of thirty-four billion cu. ft. of coal gas for heating and illumination, worth $36,000,000, in addition to over one hundred billion cu. ft. of water and oil gas, worth $90,000,000, or $126,000,000 worth all told.

The value of coal to the consumer depends upon its heating power, the percentage of water it contains, the amount and character of its ash and clinker, and how extensively it corrodes the grate-bars. For an authoritative answer to these and similar questions, the chemist must be consulted.

The composition of furnace and flue gases has been determined by chemical analyses in smelting and other industries, and by utilization of these gases for pre-heating and for the generation of power, the amount of coal consumed has been reduced, and in addition valuable by-products recovered. In gas illumination, the invention of the Welsbach mantle has greatly increased the amount of light obtainable from a given weight of coal and correspondingly reduced the drain on our coal resources. The conversion of carbon into acetylene through calcium carbide should also be mentioned.

Iron. — The total production of iron ore to date has been calculated as seven hundred and fifty million tons, believed to be 1/13th of our original stock. The production in 1907 was fifty-three million tons of ore, or twenty six million tons of pig iron, worth $530,000 000. This is nearly half of the world's total output and is equivalent to twelve hundred pounds ore or six hundred pounds pig iron per capita. The total amount of pig iron produced by the whole world in the 350 years before 1850 would now be produced by the United States alone in a little over four years. At our present rate of increase, it is predicted by Mr. Carnegie that in 40 years we shall see the end of all large deposits of high-grade ore now known. Half of our original total will be exhausted by 1938, and only lower grades left, while all now deemed workable will be gone long before the end of the present century. The lower the grade of ore the larger the amount of coal necessary to smelt it, and the higher the price of the product.

As iron, according to Clarke, composes four and one half per cent. of our lithosphere, the chances of our discovering other important deposits of ore seem far better than in the case of most other metals or of coal. The development of iron alloys is a most promising field, and among these we may find satisfactory substitutes for other metals now more seriously threatened with exhaustion. The production of ferrosilicon may render available certain siliceous ores hitherto regarded as unworkable.

The chief use of iron is in the construction of railroads and of buildings. To move 1,000 pounds of heavy freight ten miles by rail requires about an equal weight of iron in engine, steel cars, tracks, etc. As already mentioned, the development of water transportation should materially reduce this demand for iron. In building operations, concrete is helping out not only as a substitute

for iron and steel, but also as a protective covering for metallic pillars and girders.

The iron and steel industry rests mainly upon chemistry and is under chemical control at every point. The production of steel by the Bessemer process depends upon the combustion of the carbon and silicon of the pig iron, the heat of combustion serving to maintain the mass in the molten condition.

By the utilization of what was formerly the waste heat of blast furnaces to raise steam for the blowing engines and to preheat the blast, the amount of coal necessary to produce one ton of pig iron is only a quarter what it was. The slags are now largely used for the production of cement and concrete, as fireproof packing for steam pipes, as ballast for railroad tracks or for macadamizing highways, and for building purposes (slag brick, slag blocks, etc.), while those rich in phosphorus, as from the Thomas-Gilchrist process, are extensively employed in fertilizers. In the words of Mr. James Douglas: "When all the volatile products of the blast furnace . . . are deprived of their heat-giving properties and their chemical constituents, and when the slags, as well as the metal, have returned their heat to man instead of to the atmosphere, and the slag itself has been turned into cement or some other useful article, it will be a question as to whether the pig iron is the principal object of manufacture or one of the by-products."

The safety and comfort of travel on our railroads depend in large measure upon the skill of the chemist in testing the character of the materials employed in their construction and operation. It may be only a delay from a hot box due, perhaps, to a poor quality of lubricant, or it may be a disaster from the failure of a signal or headlight at a critical moment, or the breaking of an axle or locomotive part because of steel brittle from impurities.

Other Metals.—In the past twenty-five years our production of silver has increased 22 per cent., of gold 63 per cent., lead 150 per cent., zinc 537 per cent., and copper over 950 per cent.

The copper production of the United States in 1907 was 435,000 short tons, valued at $174,000,000. In the opinion of experts, the crest of our known reserves of high-grade copper ores is clearly past and we are using lower and lower grades with increasing cost of production. If, as has been affirmed, we are entering upon an age of electricity, the adequacy of our copper supply is a matter of serious concern. Chemistry has played a prominent part in copper

metallurgy. The matte is now bessemerized and 70 per cent. of our total product is refined electrolytically.

The avoidable waste in mining copper, zinc, lead, silver, and many other metals, is estimated as at least 30 per cent., but the values now locked up in the Arizona slags, the Comstock slimes, and the Anaconda tailings, will sooner or later be recovered by chemistry.

Chemistry has finally pointed the way by which *aluminum* may be obtained cheaply in large amount from its ores. In 1907, our consumption of aluminum was 8,500 tons, worth $5,000,000, the world's production for 1907 being estimated as 20,000 tons. The commercial utilization of aluminum and its alloys is writing a new chapter in our mineral industry. To appreciate what this development of aluminum means it is proper to recall that our total supply of it is nearly twice as great as that of iron, and over 800 times that of our copper. Aluminum is already replacing copper for certain electrical purposes. A large part of the power now generated at Niagara is distributed through aluminum alloy cables. It is also used for automobile castings, for airship construction, and for utensils of various kinds. The use of finely divided aluminum in Goldschmidt's "thermit" process of welding and casting is an important application of one of the chemical properties of aluminum.

A good example of the economy often accomplished by chemical investigation and discovery is furnished in the case of ultramarine. Many years ago when this was made by powdering the mineral lapis lazuli, it sold for more than its weight in gold. Now that the chemist has discovered how to make the same material from such cheap substances as kaolin, sodium sulphate and carbonate, charcoal, sulphur and rosin, the price is only a few cents per pound.

In the field of the *precious metals*, chemistry has contributed, among other things, the cyanide and chlorination processes, through which formerly rejected low-grade ores and residues have been compelled to give up their gold. The gold production of the world between 1851 and 1907 was three times that produced between 1493 and 1850. The value of our specie, upon which every commercial transaction rests, is determined by the chemist while the green ink used in printing our banknotes, and to which they owe the name of "greenbacks," was invented by a former president of the American Chemical Society, Dr. T. Sterry Hunt,

The chemist lets nothing escape unsearched. The sweepings from mints and from the shops of workers in precious metals, as well as the water in which the workmen wash their hands, are all made to relinquish the gold or silver they contain. Even waste photographic solutions must disgorge their silver before they are released. The invention of electroplating led to the extensive use of plated articles instead of solid ware and thus reduced somewhat the drain upon certain of our mineral resources.

The supply of platinum has been for years so limited that the price has ranged high. Chemistry has now put on the market vessels of transparent and opaque quartz which seem likely to replace platinum for some chemical purposes.

Many other instances might be cited where chemistry has made important contributions to the economic utilization of our mineral resources, such as the carbonyl processes of Mond, for example. But there is still much to be done in improving the present wasteful methods of smelting certain of our ores, and we may look for great advances in this direction through the rapidly developing and most promising field of electrometallurgy.

Of the various factors upon which the success of this conservation movement depends, none is more important, in my estimation, than that of awakening the producer and manufacturer to a proper realization of the value of science to our industries.

THE DISCHARGE OF SEWAGE INTO TIDAL WATERS.*

By GEORGE A. SOPER, Ph.D.

The necessity for exercising sanitary supervision over tidal harbors has arisen from the employment of water to carry away the excrement of the inhabitants of cities. Originally intended only as drains for storm water, sewers began to be extensively used for the removal of excrement about seventy years ago. This new use of sewers seemed for a while completely to solve the problem of disposing of the excreta, but with the progress of time, it was found that the difficulty was only transferred from a great number of dwellings to a smaller number of other places more or less removed. First, it was the polluted condition of rivers and lakes which showed that the problem had not been finally disposed of; more recently the question has come forward in connection with the offensive and dangerous condition of tidal harbors and other arms of the sea.

We have heard much in America of the need of conserving the quality of our inland water courses, but the sanitary protection of tidal harbors has as yet received little public attention. It is with this latest phase of the problem of polluted water that this paper will attempt to deal.

Examples of Harbors which are Protected against Sewage Pollution.

There are several cities in Europe and America which have found it necessary to protect their harbors against excessive pollution by sewage. London partly purifies its sewage with chemicals and ships to sea 7,500 tons of the resulting sludge each day. The city of Glasgow treats its sewage in the same way as does London. Dublin, Belfast and Hamburg all protect their harbors by public works which have cost large sums of money. In the United States the city of Boston and many municipalities in its vicinity have built sewerage systems which carry their sewage far

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out into the harbor in order to prevent pollution near shore. The city of Providence purifies its sewage after the London principle. Baltimore, the latest large American city to adopt a comprehensive sewerage system, has adopted a plan of sewage purification, including sedimentation, filtration and disinfection.

New York is the largest seaport which has no definite plan or policy with respect to sewage disposal. The liquid wastes of about five million people are discharged into New York harbor without any purification or regulation whatever.

In addition to the protection which they afford to the waters of some of the greatest seaports, works for purifying sewage or, at least, diverting it from points where it would become a nuisance, are becoming increasingly common for inland cities. Of the 26 cities of Europe and America which have populations of over 500,000 about one half purify their sewage or follow some other carefully devised plan for disposing of it. Of the 9 cities of over 1,000,000 inhabitants, 3 purify their sewage, one carries it away a long distance by an especially built canal and the remainder discharge their sewage into great bodies of water without any plan or concern as to its ultimate fate. Accurate statistics are not available to show how large is the aggregate sum of money invested in all the sewage disposal plants which exist, but some idea of the number and extent of those undertakings can be had from the fact that works are now in operation which purify the sewage of not less than 18,000,000 people.

Capacity of a Harbor for Disposing of Sewage.

The capacity of a harbor as a place for disposing of sewage varies with its size and shape and according to its situation with reference to the tidal currents which flow to and from the ocean. The sewage which is discharged into the water must disappear in one of two ways: it must be carried to sea by the tidal currents or be assimilated, or, as we may say, digested, by the water. Usually both processes take place in the same harbor, one or the other often being predominant. We will consider these two processes separately.

Transportation to Sea.

Mistaken confidence is often placed in the action of the tide in transporting sewage to sea. In most harbors the currents oscillate in such a way as to cause the water to be carried back and forth

on approximately the same path, sometimes for many miles at each tide, before it is permanently borne out to the ocean. In the port of London the tidal oscillation has a range of ten miles or more, and it takes from 25 to 70 days for water to pass from the upper end of London to the North Sea. In Dublin harbor, on the other hand, there are outward-moving currents which carry sewage away from the shore toward the Irish Sea at practically all phases of tide. In most harbors the oscillating currents have a net seaward gain which results from land water which flows in from rivers and other streams. In order to reduce the effects of landward-moving currents the sewage of some cities, as Boston and Hamburg, for example, is stored in reservoirs and discharged only on outgoing tides.

When sewage is discharged upon a rising tide offensive matters may not only be carried toward the land; they are also likely to be deposited there. This is particularly true in long and narrow harbors. It is well understood by rivermen that rising stages of streams carry floating matters to the shores, while falling stages carry them toward the middle of the currents. The same phenomenon appears to exist in tidal harbors. Floating sewage matters seek the shores of New York harbor as the tide rises.

The harbor of New York is peculiar in that it has two main ocean entrances. At these entrances the tidal periods are different, high water occurring a little later at Hell Gate than at the Narrows. Owing to this difference, there seems to be a movement of sea water from Long Island Sound through the East River and Upper Bay southward through the Narrows in excess of the water which flows in the opposite direction. The excess may be very slight, but there is reason to believe that an excess exists. It is important to be sure about this matter, for it may be that this harbor has been endowed by nature with on automatic flushing arrangement which can be turned to good account in cleaning the harbor of sewage. This subject is now being studied by the Metropolitan Sewerage Commission, which has been created to devise a plan or policy for improving the sanitary condition of New York harbor, and a discussion of it may he expected in the commission's report which will be issued within about one year.

The Digestion of Sewage by Water.

The digestion of sewage by water is an interesting biological phenomenon, the general nature of which can best be understood

by reference to a very simple experiment. If a sample of sewage is collected in a bottle and kept from the air, anaërobic fermentation sets in and offensive gases are produced. These gases are particularly unpleasant if the sewage is first mixed with a little sea water, sea water being in this respect much less favorable for the disposal of sewage than land water. Anaërobic fermentation is very common in stagnant parts of tidal harbors. The gases are largely imperfectly oxidized sulphur compounds, sulphuretted hydrogen being the most prominent. The color of putrid water is usually black from the presence of sulphide of iron.

If the sample of sewage in the bottle is thoroughly and repeatedly shaken up with access of fresh air it will not produce offensive odors, but the organic matter will gradually decompose. In this case the decomposition is really slow combustion. Oxygen is absorbed from the atmosphere and carbon dioxide is produced by the activities of living organisms in the water. The complex nitrogen compounds which collectively we term organic matter are converted into ammonia, and this, becoming oxidized, is transformed into nitrous and nitric acids. These acids immediately unite with the alkaline constituents of the water and become resolved into harmless and inoffensive mineral substances. This process of decomposition is continually proceeding in nature on land and in water, whether the organic matter which is being decomposed originates from sewage or from other sources. There is nothing disagreeable or dangerous in this kind of fermentation. It is the best way for sewage to be assimilated by tidal waters. To bring about this kind of assimilation the sewage must be well mixed with the water, the water must be fully exposed to the air and the proportion of sewage to water must not be too great.

The question of cost makes it necessary to take the assimilative capacity of harbor waters very carefully into account in considering how a seaport city shall dispose of its sewage. Sanitary experts have given much attention to this question, and it is not strange that some believe it to be possible to state with exactness just how much sewage a given volume of harbor water can assimilate. Opinions based on such calculations should, however, be drawn with caution. The Royal Commission on Sewage Disposal states in its fifth report that harbor water will absorb one per cent. of its volume of sewage without offense but that fish life requires a much greater dilution than this.

In nearly all harbors there are places where there is not enough water to assimilate the sewage nor suitable currents to carry the sewage matters to sea. Under these circumstances nuisance is produced. Examples of nuisances of this kind exist in many parts of the harbor of New York. Gowanus Canal, Newtown Creek and Passaic River are notorious examples of arms of tidal harbors which are offensive to sight and smell because they are supersaturated with sewage. The conditions about many of the docks and piers of New York are also offensive for the same reason.

Importance of Providing for Prompt and Complete Diffusion.

It is generally assumed by engineers that an intimate mixture at once takes place between sewage and the water into which the sewage is discharged. But experience shows that the diffusion may be very slow. The intermixture may proceed so slowly that decidedly unpleasant conditions occur before the sewage is sufficiently dispersed to disappear. Sewage matters may float about in masses upon the surface, they may accumulate upon the harbor bottom near the sewer outlet, or they may, after only partial dispersion, be carried in a somewhat diluted stream for long distances through the water of the harbor. Any of these conditions may be sufficiently objectionable to warrant the expenditure of a considerable sum of money to improve matters.

When sewage is discharged into a harbor the lighter solids rise to the top and float about upon the surface of the water. This light material may flow away from the sewer outfall in a field which is well defined if the water is not too rough or turbid to show it. The solids consist of grease, feces, paper, matches, corks, fruit and vegetable remains, bread and similar refuse. When gathered together in masses aggregating acres in extent, such as are not infrequently to be seen in New York harbor, sewage refuse is offensive to the sight. On the British coast the location of sewer outfalls is often marked by flocks of gulls which feed upon the scraps of refuse which the sewage contains. In New York city gulls feast upon the sewage in the harbor and visit the reservoir of drinking water in Central Park.

Sometimes much solid matter is deposited from sewers upon the bottom of a harbor, and it is not infrequently washed upon the shores. The sedimentation of all kinds of solids takes place more

rapidly in sea water than in land water, so that harbors are not favorable places for the disposal of sewage when regarded from this point of view.

The nature and extent of the deposits depend to some extent upon the uses to which the sewers are put and especially upon whether the sewers are used to carry away both household drainage and storm water from the streets. Storm water, particularly that which flows from macadamized roads, is likely to contain much sandy material, which will settle rapidly from the water which carries it as soon as the velocity of the current is checked. The velocity is likely to be checked when the current into which a sewer discharges flows at a slower rate than about one and one half to two miles per hour.

Solid deposits from sewage may produce offensive odors when the solids are exposed upon a shore which is laid bare at low tide or when the deposits putrify at the bottom of the water and give off quantities of offensive gas. The water about some of the docks in the New York metropolitan area effervesce with the gases which are produced by the putrefaction of sewage sludge which is going on at the bottom.

Sewage imperfectly dispersed may flow as a stream for considerable distances, particularly along shores, under the influence of wind. The action of the wind is not alone to move solid particles through the water, but it produces a horizontal movement of the whole surface which carries along whatever the water at the surface contains. The depth to which the wind may produce a movement of the water varies with the force of the wind and other conditions; the movement not infrequently extends downward for several feet. In such a landlocked harbor as that of New York a strong westerly wind causes an accumulation of sewage along the eastern shores.

Another proof of the lack of prompt and complete diffusion which sewage undergoes in a tidal harbor is afforded by the fact that when analyses are made of water collected from the surface down to the bottom, by far the greatest concentration of sewage is found to exist at the top. Similarly, when samples are taken across a harbor an accumulation of sewage is often found to exist along the shores.

Very little is known as to the ways in which sewage should be discharged so as to insure an immediate and thorough mixture. It

is evident that the point of discharge should not be at the shore line, nor so situated that the currents or wind will bring the sewage to the shore. It is equally plain that in most cases little or no sewage should empty into any part of a harbor where there is not a net seaward discharge capable of carrying the refuse away. Little is known concerning the effect of submerging sewer outfalls to a considerable depth below the surface of the water or dividing the discharging sewage into a number of neighboring streams, although it would seem that both of these plans would aid diffusion. Diffusion is at the very heart of the question of utilizing the digestive power of a harbor for sewage. Discharge only on outgoing currents is less certainly necessary, but is desirable under most circumstances. The currents should be sufficiently swift to prevent the deposit of sewage solids near the outfall and the larger solids should be removed by screening and settling. It is doubtful if we should be going too far to say that raw sewage should not be discharged into harbors whose shores are inhabited, unless under exceptional circumstances.

Capacity of a Harbor to Produce Disease.

The capacity of a sewage-polluted harbor to produce disease depends chiefly upon the chance that pathogenic microbes are present and that these may in some way get from the water into the bodies of persons susceptible to the diseases of which these microbes are the product. The sewage of a city like New York is always dangerous, for it contains the germs of every infectious disease which occurs there. To take the polluted water which flows about the docks of New York into the mouth, as do thousands who bathe along the built-up waterfront in summer, is obviously dangerous.

Bacteriologists have not yet determined how long organisms which are capable of producing disease are able to live in tidal water, but a great deal of interesting work has been done in connection with this subject. The most useful results have been obtained in studying the circumstances under which the germs of typhoid fever may persist. The results have not always been in harmony, and it must be remembered that at best laboratory conditions do not represent accurately the conditions of nature. As far as the information goes, it appears that when typhoid germs are mixed with harbor water a rapid reduction in numbers generally

occurs at once. At the end of two or three days only a small percentage of the original number of bacteria are present. At the end of about a week a further slight reduction has occurred. Some survive for two or three weeks, and under exceptional circumstances it would seem that the vitality of some typhoid germs might persist for months. Evidence is on record to show that the germs of typhoid have travelled 80 miles or more from their point of origin.

There is believed to be no reduction in the virulence of typhoid germs or other microbes because of their existence in water. The most resistant survive, and these are, apparently, well qualified to multiply and produce disease in any susceptible person. It seems a well established fact that no pathogenic microbes are capable of multiplying in harbor waters under circumstances which are at all likely to exist.

Contrary to what might be expected, there is little statistical evidence to show how much sickness is produced by polluted harbors. Repeated attempts to collect such evidence have been made, but without success. When the river Thames at London was giving off its most abominable stenches, prior to the construction of the present sewerage system, the vital statistics of the city showed no increase in the prevalence of any disease which the sanitarians of that day could ascribe to the odors. Inquiries into the health of wharfmen and boatmen indicated that their health was not visibly affected. When the river Liffey was being described as the most abominable nuisance in Ireland efforts were made to ascertain the amount of sickness near the water front of Dublin, but no excess of illness could be found.

Failure to discover an increase in disease does not, of course, prove that harm is not done to public health by such conditions. The methods of inquiry employed are too crude to detect all of the harm. Only the most conspicuous evils, such as cases of specific intestinal diseases, are looked for and the paths of infection must be plain to be seen. Subtle effects upon health, similar to those produced by insufficient air, food, sunlight, exercise and rest, cannot readily be detected, measured and traced, and it is probable that such effects are the ones which are most often produced by the ill-smelling and disgusting condition of polluted harbor water.

But, assuming it to be a fact that a polluted harbor produces no effect upon the death rate, this does not remove the necessity for

keeping the water clean, and it will do the cause of sanitation no good to make the claim that such a connection exists or is necessary. The argument for a clean harbor should be squared with the principles of the newer hygiene. It should be fully admitted that much of the powerful argument, which, for more than a century, taught that epidemic diseases were due to vapors and gases arising from ill-smelling substances has yielded to the cold light of science and has been shown to have been founded on imperfectly observed facts. The hygiene of to-day teaches that smells must be prevented because they are smells. What is disgusting and revolting to the sight must be kept from view. The higher standards of decency and order which prevail make it unnecessary to prove that insanitary conditions breed pestilence in order to provide sufficient reason to abate them.

Nevertheless, the careless discharge of sewage into harbors does produce a certain amount of sickness and death, and for those who wish positive proof of this fact there is some conclusive evidence. The best proof of a relation between polluted harbor water and disease lies in connection with shellfish. There have been more than enough cases of typhoid fever and gastro-enteritis reliably ascribed to the eating of oysters, clams and other shellfish taken from polluted waters to show that a very real danger to health exists in this direction. Shellfish taken from sewage-polluted water are always polluted themselves. They have caused typhoid fever and gastro-enteritis. In New York city cases of typhoid have been known to arise merely from handling the shells of oysters and clams taken from polluted places. The total ammount of sickness caused by impure shellfish is not known; it is probably not great, but it is certainly more than commonly supposed. Only the most striking and obvious cases come to light.

Within the last five years much attention has been directed to the need of regulating the sanitary conditions attending the cultivation and handling of shellfish, with the result that health authorities and others have been moved to abate some of the most dangerous practices. Improvements in the cultivation of shellfish have been made in Europe and America, but a great deal remains to be done. In some harbors it would appear that the shellfish industry must be given up. In others a careful management of the sewage will suffice. In places where shellfish grow plentifully without cultivation, there will always be some persons to take

them in spite of the authorities. In view of the great value of the shellfish industries, which now amount in the United States to over fifty per cent. of the total value of our fisheries, it seems incredible that the oystermen, many of whom are intelligent and of ample means, should be willing to continue to grow and handle their shellfish in an insanitary manner. In view of many so-called "oyster panics," due to public alarm, one would expect the fishermen to be the first to take the necessary steps for the protection of their business.

The Purification of Sewage.

Engineers are agreed that there is no insuperable difficulty about purifying sewage, except cost. For example, it would not be beyond the range of practicability to collect all the sewage of New York and its neighboring municipalities, amounting to, perhaps, 500,000,000 gallons of sewage per day, and convert it into a harmless and inoffensive liquid. But the expense of building and maintaining the works necessary to accomplish this result would be enormous.

Fortunately it is not always necessary to collect and purify all the sewage which is produced in the cities bordering on a tidal harbor, even when very careful measures of protecting the water are required — it may be enough to purify the wastes carried by some of the principal sewers or to divert the great bulk of the sewage to favorable points for discharge. Similarly the highest degree of efficiency in purification work may not be necessary in every case. Only such improvement may be required as will make the product inoffensive in every way when finally discharged into the tidal waters under circumstances which are favorable for dispersion and assimilation.

In protecting a harbor against excessive pollution economy demands that such engineering works as may be necessary shall be designed in a comprehensive manner and constructed in good season. The engineers should be given a liberal amount of money for preliminary studies and experiments. It is much cheaper to avoid a nuisance by providing for a suitable system of sewerage than to correct the nuisance after it has occurred.

Contrary to general belief, the manurial ingredients of sewage cannot be recovered so as materially to reduce the expense of handling it. Theoretically the manurial value of sewage amounts

to $1 to $1.25 per capita per year, but there seems to be no city in the world which is handling its sewage at a profit. It is true that some large cities, notably Paris and Berlin, utilize their sewage by irrigating farm land with it, but this requires great areas of territory and is profitable only where the soil is suitable, the land cheap or the sewage useful for the water which it contains. Some kinds of land are entirely unsuited for this purpose.

A part of the manurial ingredients can be extracted by passing the sewage through tanks, in which the solid particles can be made to settle out with or without the aid of chemicals. But this process requires the handling of large volumes of a bulky sludge containing 90 to 95 per cent. water. This sludge cannot be utilized without drying or pressing, and these procedures are expensive. If the sewage of New York was treated by precipitation with chemicals it is estimated that about 14,000 tons of sludge would be produced each day. The difficulty and cost of disposing of this sludge would be great.

The bacterial processes of purifying sewage which have been developed in the last ten years do not aim to recover the fertilizing ingredients. Their sole object is to dispose of the impurities in a harmless and inoffensive manner and with the least expenditure of time and money. Some of these bacterial processes are of much scientific interest and considerable progress is being made in improving them. Perhaps the most novel bacterial works for the disposal of sewage which are now being constructed are those of Belfast, where it is expected that a certain amount of the organic matter will, through the action of microörganisms, be driven into the atmosphere in the form of inert and harmless gas. It is necessary in this case to keep even the usual mineral ingredients of purified sewage out of the harbor as far as practicable, lest they serve as fertilizer for seaweed. At present a weed called sea lettuce grows so luxuriantly in the sewage-polluted harbor of Belfast that the harbor is nearly choked with it. The seaweed dies and rots and creates nauseating odors.

If sewage is screened and passed through properly constructed settling tanks the visible particles may nearly all be removed. Screens have been brought to a high state of perfection in Europe, where they have been employed to remove particles as small as 1/25 inch. The screens at Hamburg have bars about 3/5 inch apart, but they are allowed to become partly clogged and so

remove very small particles. In connection with screening, grease may also be extracted from sewage. Screening, settling and the removal of grease are extensively practiced in Germany as a suitable procedure preliminary to the discharge of sewage into rivers which are not used for drinking purposes. The cost of this treatment is comparatively small. The benefit, when regarded from the æsthetic standpoint, is large.

Forms of Sanitary Control.

The appropriate legal authority to exercise sanitary control over a tidal harbor must depend upon local circumstances. Over matters which are surely and simply of public health import it is obvious that boards of health should have jurisdiction. Where questions affecting public comfort and well being are chiefly concerned some other form of jurisdiction is, at least, equally appropriate.

The main authority in charge of the sanitary protection of the Thames is not a public health body. The royal commissions on sewage disposal of Great Britain have, with one exception, not been health boards. The various Rivers Boards of England, which are doing good work for the sanitary protection of watercourses, are committees composed of local authorities and are charged with the special duty of preventing nuisances.

The last report of the (temporary) Royal Commission on Sewage Disposal recommends the creation of a permanent central sewage authority which shall carry on suitable investigations and be ready to give expert advice to local authorities as to methods for the sanitary disposition of sewage and act as a court of last resort in all matters of dispute concerning the disposal of sewage in the several localities of England.

In Germany the imperial board of health exercises jurisdiction over streams only in so far as health is surely and directly concerned. The sanitary improvement and protection of the rivers, so that they may be maintained in a condition suitable for the business and enjoyment of the public, devolve upon other authorities.

In America, where there is no central health authority, the protection of the watercourses is left to the care of the individual states. Some states require that all plans for sewerage, as well as sewage purification, shall be passed upon by the State Board of

Health before they are carried out. American harbors are protected, where any protection exists, chiefly through works constructed by sanitary authorities, such as sewerage commissions, which have no jurisdiction over matters of public health. The need and nature of such work are often determined by a special board of commissioners. This has been true of Boston and Baltimore.

The investigations now being made preparatory to devising a comprehensive plan to protect the sanitary condition of New York harbor has been placed by the State of New York in the hands of a special investigating commission, consisting of four engineers and one physician, called the Metropolitan Sewerage Commission. The work of this commission involves investigations requiring the making of thousands of chemical and bacterial analyses, systematic inspections, studies of tidal currents, investigations of the transporting and digestive capacity of the harbor for sewage and a careful consideration of the desirability and practicability of different methods of treating the sewage of the many cities and towns within a radius of twenty miles or so of the New York City Hall. The problem is a large one, for within the district mentioned there exists a population of over 6,000,000 people, and the number is increasing rapidly. Satisfactory progress is being made with the investigations and the report of the commission may confidently be expected by May, 1910.

A FACTORY STOCK AND COST-KEEPING SYSTEM.

By WALTER J. SPIRO.

The problem of keeping track of the stock of parts on hand, in order to issue orders for the replenishment of this stock in proper season, and the allied problem of determining the cost of manufacture of these parts, in spite of their apparent simplicity have puzzled the brains of factory-managers ever since the factory system began. Indeed, so important is this matter of stock and cost-keeping that there is to-day more than one concern whose sole business is the advising of the executives of manufacturing plants as to the best possible solution of the problem as applied to each particular case. As an outgrowth of the great amount of thought that has been brought to bear on this question, ingenious devices have been developed to lighten labor and increase efficiency, among these being the well-known time-clock in its various forms; the so-called calculagraph (an instrument for mechanically subtracting the time of starting from the time of finishing a job, thus showing the elapsed time in hours and minutes); and many others of similar purpose. One large manufacturing concern has even gone to the length of attaching a telephone-instrument to each of its machine-tools, so that the operator may periodically communicate to one of the cost-clerks in a central office the necessary data for computing the cost of production.

It is, however, not the purpose of this paper to discuss the broader aspects of the problem, but rather it will confine itself to a description of the manner in which it has been solved by one manufacturing concern to its own satisfaction and profit; and while the plan here laid down is by no means to be considered as a universal system which will fit all cases, it will nevertheless indicate the principles involved in most successful systems of this sort.

The plant with which we are concerned is engaged in the manufacture of a product containing about fifteen hundred parts of about three hundred and fifty different kinds; and the total weekly production runs well up into the hundreds of thousands of pieces. In many instances it requires over a month to carry a part to com-

pletion through all its various stages of manufacture, so that the importance of a well-developed system for keeping track of the parts and orders may easily be seen. There are three stock-rooms, for the storage of raw material, tools and finished parts respectively, and adjoining the latter is the inspecting department, through which all parts must pass after each operation.

The stock and cost-keeping, as well as certain other details of factory routine such as time-keeping, etc., are in the hands of three clerks and their assistants, and are under the general supervision of the shop superintendent, who alone has power to vary any detail of the routine. The stock-clerk receives, handles and delivers the parts, both finished and partly-finished. The cost-clerk keeps track of stock on hand, makes out all manufacturing orders (which must be countersigned by the superintendent to be valid), and computes the cost of manufacture of each lot of parts. The time-clerk registers the attendance of each employe as shown by the time-clock record cards, makes out the weekly pay-roll, and attends to certain other matters as will be explained later.

Of all matters coming under the jurisdiction of the stock-system perhaps the most important is the ordering of raw material, since in most instances this material is of a special nature and cannot be procured in the open market, and frequently from four to six months must elapse after placing an order before the material is received — so that a failure to order on time might result in an entire stoppage of business. To guard against such slips a record of the stock on hand of each size is kept on a ticket (Form W, Fig. 1), which constantly shows the exact balance on hand. At

No. or Size.	C. T. W. Co.—MATERIAL STOCK RECORD.—Form W.	BIN No.	MIN.
	NAME.		MAX.

USED FOR

Date.	Balance.	Hand.	Date.	Balance.	Hand.	Date.	Balance.	Hand.

FIG. 1.

the head of this ticket are columns labeled Max. and Min. The former indicates the amount of stock to be ordered, while the latter shows the minimum amount to be carried; and when this point is reached the stock-clerk immediately hands the purchasing agent an order for a fresh supply of the stock in question. These maximum and minimum amounts are carefully figured from data as to the average weekly consumption of the stock, the time required to secure same, and a "factor of safety" to take care of unforeseen circumstances; and they are frequently revised as internal or external business conditions require. To insure against lapses on the part of the stock-clerk, a duplicate set of tickets is kept by the

C. T. W. Co.--Form R--7
REQUISITION

JOB NO. *C-12-15*
DATE *3/13* 1909

	To be filled in by workman	To be filled in by stock clerk
Raw Material	NAME OF PIECE *Long Pivot.*	SIZE AND KIND OF STOCK *.101" Drill-Rod*
	NO. TO BE MADE *25,000*	QUANTITY *246 lbs.*
Supplies	QUANTITY / KIND	
	WANTED FOR	

Received by No. *341*	Foreman's Signature *A. B. C.*
Filled by	Entered by

FIG. 2.

time-clerk, the requisition tickets being sent to the latter for this purpose after being filled. Further, the material itself is carefully weighed every three months, and the amounts compared with those shown by the record-cards. These various safeguards operate so perfectly that in five years not a single serious slip has occurred, although the stock comprises several hundred tons of material of over two hundred different kinds.

The requisition ticket (Form R–7, Fig. 2) referred to above is used for ordering both raw material and supplies (such as tools, finished parts, etc.). Its use will be further described hereafter.

Next to the ordering of raw material, the placing of shop orders for manufacturing the various parts is the most important matter

CARRIAGES No. 12

LIST FOR ORDERING PARTS.

	Date Ordered	NAME OF PARTS	Amt to Order	Min. on hand	COURSE	REMARKS.	BALANCE.	Amt.	Date Ordered
○		Back Sp. Arm 10 pitch	3000	300	○ 1st ○ 2 ● 4 ○ 2	Order together with 13 ½ Stop	○ ○ ⑤ ⑤ ⓪		
○		" " " Stop	3000	300	○ 1 ○ 4		○ ② ④ ⓪ ⓪		
○		Back Sp. Lever	3000	300	○ 1 ● 2 ○ 4		○ ○ ⑤ ⓪ ⓪		
○		" " " Screw	12000	1000	● 3 ○ 4		○ ○ ⑨ ⓪ ⓪		
●		" " " Pivot Screw	12000	2000	○ 3		○ ○ ○ ⑤ ④		
○		" " " Washer	12000	500	○ 1 ○ 4		○ ⑧ ④ ⓪ ⓪		
○		Ball Races, Front, 10"	1000	300	○ 3 ○ 4 ● 2 ○ 4	Order 10 12, 14, 16, & 18" Front Races Together	○ ○ ⑤ ② ⓪		
●		" " " 12"	200	60	○ 2 ○ 4	in lots of 3000 for 1st & 2d op. and keep in	○ ○ ○ ⑨ ⑤		
○		" " " 14"	150	40	○ 2 ○ 4	surfin. Track ready for the different lengths.	○ ○ ① ⑦ ⓪		
○		" " " 16"	500	250	● 3 ○ 4		○ ○ ② ④ ⓪		
○		" " " 18"	125	35	● 2 ○ 4		○ ○ ○ ③ ⓪		
○		" " " 22"	100	25	○ 2 ○ 4 ○ 2 ○ 4 ○ 2		○ ○ ○ ⑨ ⓪		
○		" " " 27"	150	40	○ 2 ○ 4 ○ 2 ○ 4 ○ 2		○ ○ ① ① ⓪		
○		Ball Race Adjusting Screw	20,000	2000	○ 3 ● 4		○ ○ ⑧ ⓪ ⓪		
○		" " Binding Screw	50,000	5000	● 3 ○ 4		○ ③ ④ ⓪ ⓪		
○		Carriage Holder	"	800	● 2 ⊗ 4	Order 800 per week until multiplied by Separate	○ ① ② ④ ⓪		
○							○ ○ ○ ○ ○		
○		Jumper Paul	10000	1000	○ 1 ○ 4 ○ 2nd 2 ○ 4 ● 6	Order for 28 mm following gr. in lots of 1000 only	○ ○ ⑦ ⓪ ⓪		
○		" " Rivet	50000	10000	○ 3	and keep complete in surfin. Stock	① ② ⑨ ③ ⓪		
○		Platen Detent	5000	500	○ 1 ○ 4 ● 2 ○ 3 ○ 4 ⊗ 3		○ ○ ④ ⓪ ⓪		

FIG. 3.

with which we are concerned, and the basis of this is the stock-board, of which a sketch is appended hereto, Fig. 3. This board is the outgrowth of several years of experience during which a number of different devices to accomplish its purpose were tried. These varied from bound books through the various stages of loose-leaf ledgers, record-cards, etc., to a "machine" consisting of a box containing two rollers on which was mounted a long band of paper about three feet wide, containing the various facts as to stock on hand and under manufacture. The board overcomes the defects of all the other devices, and has proven highly satisfactory as a means of indicating the time to order stock.

The board is three feet high by five feet wide, and contains a series of horizontal columns in which are entered the names of all the parts which the plant manufactures. The entries are all made by means of small variously-colored metal plugs inserted in suitable holes in the board, these plugs being nickel-plated, copper-plated or black-japanned, and the heads of some of them being stamped with figures from 0 to 9. At the extreme right of the board is a column headed "balance," and there are five holes in this column opposite each part-name. By inserting proper numbered-plugs in these holes, any, amount up to 100,000 may be indicated, and it is the duty of the stock-clerk, whenever he receives or delivers any finished-parts, to alter the number-plugs opposite the name of that part so that they always show the exact number of pieces in stock. Opposite the name of each part is printed (in a column headed Min.) the minimum number of parts to be kept on hand. When altering a balance-number, the stock-clerk glances at this minimum entry, and should his balance be down to the quantity there indicated, he inserts a red plug in a hole at the left of the part-name. This indicates to the cost-clerk that it is necessary to make out a manufacturing-order for a new supply of the parts in question.

Twice each day the cost-clerk goes over the board and makes out the necessary orders. After entering an order he removes the red signal-plug, and in its stead places a white plug in a hole showng the number of the department in which work on the part is commenced. The columns giving this information are at the right of the part-name, and the numbers in these columns, reading from left to right, indicate the sequence in which the various departments of the plant operate on the piece. When the first operation on the pieces has been finished, they are sent to the inspector, and

thence to the stock-room. The cost-clerk immediately makes out an order to the second department concerned with the particular piece to perform its operation on same, and he then removes the white plug from the first hole and places it in the second. This procedure is observed through all the various operations until the pieces are completed and turned into finished stock, when the balance-plugs are changed to indicate the new balance. Thus it is possible at any time to determine, by simply looking over the stock-board, how many of each part are in stock; when it is time to order a new supply of any part; what parts have been ordered; how far their manufacture has proceeded; in what department the pieces are located; and whether it is necessary to rush through a portion of the lot to meet immediate needs (as shown by a dangerously small balance). It is also possible to determine just what manufacturing orders each department has on hand at any time, as shown by the location of the white plugs. The usefulness of all this information to the shop-superintendent may be readlly imagined, though the prime purpose of the board is to prevent delays in ordering parts.

As indicated above, it sometimes happens that although a supply of a given part has been ordered in ample time, some unforeseen drain on the stock may deplete the latter so that a new supply is immediately necessary. In this case the assistant superintendent, whose duty it is periodically to examine the board for this purpose, will order that the lot of parts in process of manufacture be split up, one part of the lot being pushed through to immediate completion, while the remainder follows along in the usual course. This is one of the most puzzling contingencies to be taken care of in the average stock-system, but the board handles it perfectly. If we assume that a portion of the lot has been sent to department No. 4, while the balance remains in department No. 2, the cost-clerk simply places a black plug in column No. 4, opposite the name of the part, leaving the white plug in column No. 2, and thereafter he moves the black plug in unison with the movements of the first partial lot, while the white plug follows the balance. In this way a lot of parts may be split up into as many different partial lots as the circumstances may require, and still the location and progress of each section are clearly indicated.

We have seen how the cost-clerk is informed when it is necessary to issue an order to make a given part. Now let us see how that order is given and carried out.

The first step is to fill out a manufacturing order (Form MO, Fig. 4) with the necessary particulars as to the name of the part wanted, the number to be made, the department in which they are to be started, the date when they must be finished in that department, and a job number, which is simply an arbitrary number to distinguish the lot. (This job number, by the way, is made up of a letter indicating the month, a number indicating the day of the

C. T. W. Co. **MANUFACTURING ORDER.** Form MO

JOB No. *C-12-15* | DATE

Foreman, *Screw* Dept.; Make the following parts, and deliver not later than *3-20*

No. *25,000* | NAME OF PART *Long Pivots*

Date	No. Delivered	Remarks	Date	No. Delivered	Remarks
3-19	*25,220*				

Hold this Ticket until Job is finished and return to Inspector with last lot.

FIG. 4.

month, and a number indicating the job. Thus, C–12–15 represents the fifteenth job ordered on March 12. This saves writing the date separately, and insures that all tickets relating to the job will indicate when the order was given out, thus avoiding undue delays.)

The manufacturing order thus filled out is handed to the superintendent, who stamps it with his initials, when it is turned over to the proper foreman, who files it alphabetically in a card-index box. When the foreman is ready to start work on the job, he fills out a requisition-ticket (Form R–7, Fig. 2) with the particulars as shown on his order, and sends it to the stock-clerk. The latter consults a list which shows the kind and amount of material required to make the part in the number called for by the requisition, and after filling the order he enters these data on the requisition. These requisitions after being filled are sent to the time-clerk, who enters up his stock-records from them and forwards them to the cost-clerk, where they serve as a basis for figuring the cost of material on the various jobs.

Having the material, the foreman now decides which of his men

is to work on the job, and then fills out a work-ticket blank (Form A–7, Fig. 5) with all the particulars as shown on the order except the number of pieces, and in addition he enters in the proper columns the name of the first operation, the workman's number, and the date and time of starting work. When the first operation has been completed he marks the time and date of finishing, and in the next column on the work-ticket he enters the name of the second operation, and the number and date as before. When

C. T. W. Co. **WORK TICKET** FORM A—7

Job No. *C-12-15*	Delivered by *Screw* Dept.	Date *3/19 1909*
NO. OF PIECES *25,220*	NAME OF PIECE *Long Pivots*	

Operation	Hand No.	Started	Finished	Time, Hrs.	Rate	Cost
Auto S\M	*341*	*3-13\7.00*	*3-19\4.30*			

The above pieces have been received and checked by

Inspected by	No. passed	No. defective	Cause
Total cost	Cost per 100 pieces	Entered by	

FIG. 5.

finally the pieces are completed as far as his work on them is concerned, he sends them, together with the work-ticket and the manufacturing order, to the inspector, who counts the pieces and signs his initials, as a receipt for the goods, in the proper column of the work-ticket.

If the foreman is ordered to split up the job, he marks on the work-ticket, in the column headed No. of Pieces, the number of parts in the first partial lot, enters in the column labeled Finished the time of finishing the partial lot, and sends this lot together with the work-ticket to the inspector. He retains the order, and fills out a new work-ticket for the balance of the job, entering on the order the date of sending up the first lot and the number of pieces in the lot. When the balance of the pieces are completed and sent up, the order is sent with them.

When the pieces have been inspected and the inspector has marked on the work-ticket the number of parts he has found O. K. and the number defective, together with the nature of the defect, he turns in the ticket to the cost-clerk, who immediately makes out a new order, bearing the same job number, which is sent to the second department concerned with the parts. The foreman of the second department, instead of ordering raw material for the job, makes out a requisition for the proper number of partly-finished pieces, which are delivered to him by the stock-clerk. He then proceeds to fill out a work-ticket as already explained.

C. T. W. Co. **REPAIR TICKET** FORM W. R.

Job. No.	Returned to Dept.	Date Returned, 190

NO. OF PIECES RETURNED | NAME OF PIECE

Operation	Hand No.	Started	Finished	Time, Hrs.	Rate	Cost

The above pieces have been received and checked by

Inspected by	No. passed	No. defective	Cause
Total Cost	Cost per 100 pieces	Entered by Cost-Clerk.	

FIG. 6.

Meanwhile the defective pieces (if the defect is one that can be remedied) are sent back to the first department together with a repair-ticket, Fig. 6, filled out by the cost-clerk, this ticket being practically a duplicate of the work-ticket and used in the same way, except that no pay is allowed for the time entered on it.

It is to be noted that, as all pay is made up from the work-tickets, it is necessary that the latter should be in the hands of the cost-clerk by Wednesday night, which is the time the working-week ends. Accordingly, if a job is still uncompleted at that time, the foreman closes his ticket and sends it down with the parts which have been finished, starting a new ticket for the balance on Thursday morning.

The cost-clerk keeps a set of record-cards (Form CC, Fig. 7) on

which he enters the name, date and quantity of parts he orders, and also the date and quantity delivered, so that he may have a suitable record in case the work-ticket is lost.

Name of Part	ORDERED			DELIVERED
	Order No.	Date	Quantity	Quantity
Long Pivot Screw	*C-12-15*	*3-12-09*	*25,000*	*3-19-25,220*

C. T. W. Co. Form CC

FIG. 7.

On Thursday morning the cost-clerk starts to make out the weekly pay-roll, having before him, as has been explained, all the work-tickets for the week. On his desk he has a rack containing a series of pay-cards (Form PC, Fig. 8), one for each hand, ar-

C. T. W. Co. **PAY CARD** Form PC.

.....Dept. Hand No. .....Week ending 190

Date	Job No.	Hours	No. of Parts	Operation	Price	Amount
Total Hours			Wages for Week			

FIG. 8.

ranged in numerical order. He has already entered on the work-tickets the value of each operation, having for this purpose a chart showing the rate per hour of day-workers and the rate per hundred of piece-work operations. He now takes each work-ticket in turn and enters from it on the pay-card corresponding to the hand who did the work, the name and number of parts, the amount to be paid and other details. When all the work-tickets have been entered the pay-cards will show the entire productive pay-roll for the week and the tickets are now sent to the time-clerk, who, after checking the time of the day-workers with their time-clock cards and the product of the piece-workers with the inspector's report of goods passed, makes out the pay-roll from the totals shown by the pay-cards.

C. T. W. Co. **COST CARD**—ALL PRICES IN CENTS PER HUNDRED PIECES Form F

NAME *PIVOT-LONG* **NO.** *472*

Job No.	Started	Material	1 Operation *Screw*	2 Operation *MFG*	3 Operation *Press*	4 Operation	5 Operation	6 Operation	Total Mfg. Cost	Fixed Ch's *35 %*	TOTAL
G-12-15	*3-12-09*	*20*	*45*	*32.2*	*12*				*109.2*	*38.2*	*147.4*

FIG. 9.

It now only remains to compute the cost of manufacture of the various parts which have been completed, and for this purpose a cost-card (Form F, Fig. 9) is used. A cost-card is filled out with the name and shop-number of each piece made, and these cards are kept in a card-index, alphabetically arranged for easy reference. When a job is started the cost-clerk enters the job number and date on the

cost-card. Upon receiving the requisition for raw material bearing the same job number, he computes, with the aid of a list of prices per pound of the various kinds of material used, the value of the material taken out for the job, reduces this to a cost per 100 pieces, and enters it in the Material column on the card. As each work-ticket comes through he enters at its foot the total cost of the operations performed, and the cost per 100 pieces, which latter he transfers to the cost-card. When all the operations have been completed he totals across the card to obtain the total manufacturing cost, and adding the proper percentage of fixed charges (which are determined each year by comparing the year's total productive expense with the total overhead expenses), he obtains the total cost of the parts, which he enters in the total column of

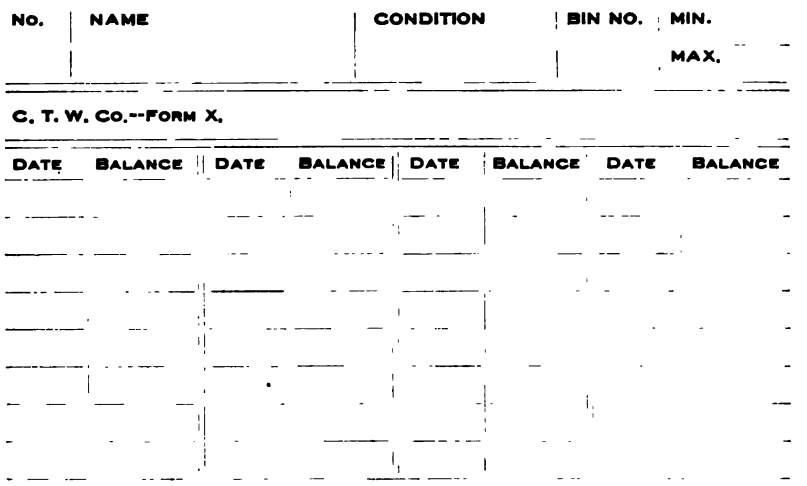

FIG. 10.

the cost-card. He sends a weekly report to the superintendent which states the cost of making all the parts which have been completed during the week, and if any lot of parts has cost more than the last lot of similar pieces, he writes them in red on the report, thus calling the superintendent's attention to the fact that the job needs his attention.

Two tickets are shown whose use has not been explained. These are Form X, Fig. 10, which is kept in the finished-parts stock-boxes, and on which is entered the balance of parts on hand at all times, thus serving as a check on the stock-board; and the

stock-clerk's memorandum (Form D, Fig. 11), which is filled out at the time of making out a manufacturing order and filed in a card-index under the date when the parts should be finished, thus calling the clerk's attention to any delay in filling the order. This completes the operation of the system, which, as we have seen, furnishes all required information as to cost of manufacture, stock on hand and in work, time to order parts and raw material, amount of workmen's pay, and all the other details which it is necessary to know in running this department of a factory. While it involves a certain amount of "red-tape," it is the experience of the writer

C. T. W. MFG. CO. FORM D

STOCK-CLERK'S MEMORANDUM

Date Ordered *3-12-09* When Wanted *3-20* 190 *9*

Quantity *25,000*

Material *Long Pivots*

Wanted For *No. C-12-15*

FIG. 11.

that no system which adequately meets the requirements demands so small an operating force and so little clerical work on the part of the foremen as the one described, which in practice has conclusively demonstrated its suitability for the class of work performed by the plant in question. Though, as stated in the beginning, no system can be devised which will fit ready-made all the conditions to be found in various manufacturing plants, even in the same line, yet it is believed that the above will indicate the principles which, if properly applied in a shop manufacturing small parts in quantities, will successfully fulfill all the requirements of a stock and cost system.

ALUMNI DINNER.

About three hundred alumni of the Schools of Mines, Engineering, Chemistry, and Architecture dined at the Hotel Astor on February 17. The dinner committee consisted of George H. Clark, '93 (chairman), L. E. Gregory, '93, W. F. Beekman, '96, P. A. Bates, '97, M. S. Falk, '99, E. L. Satterlee, 1900, D. M. Myers, '01, W. H. Yates, '03, and M. Deutsch, '06.

Daniel E. Moran, '84, president of the Alumni Association acted as toastmaster and the toasts were responded to by Dean Goetze, John B. Pine, '77, and Professors Van Amringe, Chandler, Munroe, Hutton, Kemp, Burr, Hamlin, and Tombo.

The addresses were in part as follows:

BY PROFESSOR VAN AMRINGE:

Gentlemen: I am very glad that your chairman has claimed me for his own. I claim you all for my own also. I went into the School of Mines, as it was called, as soon as there was a school of mines to go into and I am happy to say that I have been there ever since. If I understood aright the very kind and cordial invitation from Mr. Clark, this gathering is in the nature of a love feast — a prelude to the coming day, the happy day, I hope, of millennial delights when the alumni of Columbia, irrespective of schools, will get together as a veritable band of brothers. A little while ago, it seems but the other day, Columbia was a small college of less than two hundred students; it is nowa great national and international university, more than twenty times as large, and far more varied. Even in my little span of life, I have seen the several schools that now constitute the great whole, rise, lean for a time as they did on the college and get nutrition from it, and, having gained vigor and ambition from its abounding vitality, separate from it, go their several ways, become great and famous. For years these schools, that are an honor to New York and a glory to Columbia, pursued independent courses, each in its own sphere, with little or no reference to any other. Then under our present chief and his immediate predecessor they were drawn closer and closer together, until now the whole university, from the college through all the professional schools and advanced

courses of instruction, is a single educational entity, permeated by the same spirit, impelled by the same motive, the same ambition of service, and conducted on the same general plan and by the same general method. It is right then that all the alumni of all the schools should meet and rejoice together, extol and magnify their common mother that has done so much for each and every one of them and receives from them in return the satisfaction and the distinction given by a numerous, an eminent and an attached progeny. If there is any such thing as an especial propriety in the alumni of any two of the schools meeting as one body it would seem to belong to those that are here represented — engineers and architects. They were born under the same roof, rocked in the same cradle, and constituted, after the establishment of the school of architecture, one family for many years. They were not, however, even in fundamentals common to the two, served with the same dishes. The architects had their mathematics and mechanics in packages especially prepared for them. Professor Ware, a name ever dear and honored here, wanted the architects all to himself, and being a forceful man as well as a most admirable instructor, he had his way. He arranged courses of mechanics and mathematics, under a general title of architectural engineering, suited to the taste and effective in the nourishment of those for whom they were prepared. They were pictorial and picturesque courses — and they were good ones too, as every one knows who knows their source and knows also the accomplished professor and prince of good fellows who gave them, my friend, Frank Sherman. Not long after our well-beloved friend Ware left us to take a well earned repose, his children left the family of which they had from the first been members and established a separate home of their own — and that new home became the nucleus of a School of Fine Arts. When they became settled in their new home they became restless; they exhibited a characteristic of frail human nature from which even architects are not exempt — they regretted something that they had left behind and which they had not before appreciated. They developed a new and strong desire to participate in a possession of the engineers which they had previously disregarded, not to say disdained. And what do you think that was to which their eager, longing, loving glances were directed? Why, mathematics — just plain mathematics — and their desire was gratified. And so once more we have the architects and the engineers

joined in certain essential parts of their early professional preparation. They have always been in practice, I believe, as to many of their enterprises, the complemental factors of successful accomplishment. Together they represent a combination unexcelled in attractiveness and in effectiveness, whether in the domain of character and influence or in that of works of hand and brain, solidity, stability and beauty. It is good and profitable for you and the university that you should come together, socially, as you have this evening, on the ground of fealty to a common Alma Mater. Long may you continue to have "One feast, one house, one mutual happiness."

By Professor Chandler:

Mr. Chairman and my dear old boys: This is the only opportunity I ever have had in my life to speak to an audience with the knowledge that every one of them knows me better than I know myself. Every one of you was compelled to sit for two long years and listen to what I had to say. Many of you who selected chemistry as your specialty had to add another two years. For four long years some of you (here's my friend Goldsmith; there's Ricketts and I see many others) for four years you had to listen to me and yet you look as though you could listen for another four. I really think that those poor chemists in the four years were nearly talked to death. The engineers were let off in two years. Every one of you has been my victim. It's a great treat to come here and meet you all again. I cannot tell you what a pleasure it is. I am not obliged to put on any airs, there would be no use in doing that. I have to make no pretenses. You saw through me, right straight through, and I have nothing to do but to come here and say it gives me the greatest pleasure to meet you again. It gives me the greatest pleasure to feel that possibly on some occasion or other I may have said something that was useful to you. One of you whom I met to-night, whom I shook by the hand, says he has kept his internal economy in order for twenty-five years because I told him to drink a pint of water every morning as soon as he got out of bed. He might have been gathered into an early grave but for that happy thought which came to me that morning and which I put into words to the class. There is no one in this room except "dear old Van Am" and myself who taught in the school of mines in the early days. Jack

Adams, the first graduate, who graduated in 1867, died many years ago. As there are but few here to-night who were with us in those early days it might not be out of place for me to tell you how it all came about. I feel that I owe a great debt to that man whose picture hangs behind us, and I shall never lose an opportunity to impress on the graduates of the School of Mines the debt that they owe to him. Tom Egleston, of Yale, and Francis Vinton, of West Point, graduated as mining engineers at the School of Mines in Paris. They came home in '62 or possibly in the beginning of '63 and it occurred to Egleston that as there was no School of Mines on this side of the Atlantic, that it was time there should be one, and he carefully prepared a plan for a School of Mines in New York, this he printed in pamphlet form. I have carefully taken two copies, torn them apart, mounted them on a cardboard sheet and hung them in the entrance of Havemeyer, so that no one will ever forget that in 1863 Tom Egleston devised and published a plan for a School of Mines in the City of New York, and you know that we are pursuing that plan to-day. The general outline of that plan is to-day the one on which the school of mines is conducted. Egleston sought means to establish that School of Mines. He consulted Mr. Peter Cooper, of the Cooper Union, and laid his plan before him, but Mr. Cooper said "Mr. Egleston, your plan is diametrically opposite to the plan of Cooper Union. Here we undertake to give a moderate amount of education to a large number of men. You are proposing to give a most comprehensive education, in a particular direction, to a very limited number of men," and said he "I don't think that your scheme would fit into ours."

He then went to one or two of the Trustees of Columbia College and made the proposition to them. They had undertaken a few years before to establish a course of higher studies at Columbia in a line which had not proved a success, if I remember correctly, it was before my time, and they were not particularly disposed at this time to undertake a new enterprise of this kind. Their finances were extremely low. They had borrowed an enormous sum of money, for the times, and they had nothing to give. But the interest which Egleston created was such that they were disposed to encourage the enterprise, provided he could find the means, outside of the college, to make the beginning. He did not succeed in finding very extensive means; but he interested William

E. Dodge, Jr., Percy R. Pine, Franklin H. Delano, Dr. Agnew S. W. Bridgham and several others, some twenty gentlemen in all, in the subject, and they finally gave him five thousand dollars as, a beginning. The trustees said he might establish a Schcol of Mines provided he would not ask for any money, and of course, he could not expect to have any salary, and if he could succeed in interesting any other persons who would assist him in giving instruction on the same terms, he might open the school. Of course, Vinton, his colleague, was his first selection for the engineering side of the subject and, by accident, I had made his acquaintance a year before. Edward C. Delavan, of Albany, had given to Union College a very choice collection of minerals made by Charles S. Wheatley at the Phœnix Mine, who with the duplicates obtained from that mine had accumulated a most wonderful collection of minerals. Mr. Delavan gave the collection to Union College and it was placed in my charge. Mineralogists from all over the country came to Schenectady to see that collection of minerals and among them was Egleston. He stayed at my house for two or three days and was very much interested in the little laboratory I had there. He inspected the furnaces I had there, to make assays of gold and silver, and one day he suggested that I might, perhaps, join him in this enterprise, and come to New York, and take the chair of chemistry. I happened to be married and I had a child in arms, and to come to New York, without any salary, to take a hand in an enterprise that did not exist except on paper was rather a startling proposition. But I had so much faith in the enterprise that I promptly accepted the invitation. The only capital I had was a thousand dollar bond that my wife's grandmother gave her when she was married. But I had so much faith in the possibility of the School of Mines in New York being successful that I never dreamed of failure. It never entered my mind that the thing would not be a great success. Some of my friends at other colleges ridiculed the idea. They said: "You never can have an institution of higher learning in the City of New York; the people are all money grubbers there; they would never support anything of the kind. How foolish you are to give up a certainty at Union College to come to New York on such an unpromising undertaking." Well, I came. It is but just to say, however, that when these gentlemen who gave Professor Egleston the $5,000 to fit up a little laboratory in the kitchen of Dr. King's house and a mineral cabinet,

heard I was coming, they sent to me and stated that I must not have any anxiety; they would see that I should have at least $1,500 the first winter so that I might be sure my family would not starve. Do you know, we had twenty-four students the first day! Some of them were college graduates. One of them was a civil engineer in good practice. Twenty-four young men came on the fifteenth of November, 1864, and enrolled themselves in the new School of Mines. We had only put up tables for twelve students and we had twenty four. We had spent our $5,000. We immediately ordered in the carpenters and gas fitters.

I might tell a little story that is amusing in that connection. There was a college carpenter, a college plumber and a college gas fitter, and when we undertook to spend this $5,000 and make it go as far as possible, we drew plans for the little laboratory and little mineral cabinet and asked these people to estimate. Their figures were so high that we could not afford, out of our little pittance, to employ them, and I went down to Third Avenue and found a carpenter, a plumber and a gas-fitter who undertook to do the work for half. I engaged them. We had the spending of $5,000 but it was in the hands of Mr. Ogden, the college treasurer. When our bills went in, he, being a careful man, closely scrutinized those bills, and when he drew out the bills he had paid before, he discovered that our bills were only about half as much. He came to the college and looked at the work, found the carpenter work good, the gas-fitting good and the plumbing good, and immediately shipped the college carpenter, gas-fitter and plumber and took those of the School of Mines. We were going to do things practically, and that was the first success we had, and Gouverneur Ogden became one of the strongest friends the School of Mines had. When we had twenty-four students and places for twelve, we immediately ordered the carpenter and gas-fitter and plumber in and had them put up some more tables; and then some more students came and we had some more tables put up, and some more students, and some more tables, and so on. We ran in debt $6,000 and had not the slightest idea where it was coming from, but we took our chances. Our faith was so great that we did not hesitate. We had forty-seven students at work in that new School of Mines that New York "would never support." The trustees heard how we were getting on and sent a committee to look into matters, and Dr. Haight took sides with us at once. He said:

"We have had a baby born on our hands, this young School of Mines must be clothed." And he insisted that the trustees should borrow ten thousand dollars, pay our debt of six thousand, and provide for the remainder of our first year. That was the first experience. We had forty-seven first rate fellows; they really wanted the education. They did not come there because their fathers did not know what else to do with them, they came because they wanted the education. We had very little to offer. It was a miserably poor place down there in the old kitchen and laundry of President Charles King's old home. We could not even afford to hire a janitor at first. The college janitor looked askance at us and would not do anything for us. Finally we hired a lame soldier, who went on a spree every now and then, and, as I knew if we did not get comfortably through the first winter the school would end with the year, I used to hurry up there in the morning, and, when the lame soldier was not to be found, I took off my coat, sprinkled the floors, swept them myself and made the fires. I was bound to see the school through the first winter. And many a day I did that drudgery because it must be made as pleasant and convenient for the boys as possible; and we did have a lovely time. I was right in among them. I was a boy myself, then, twenty-eight, and many of the students were older than that. We used to go over to Fritz's on Fiftieth Street, eat our sandwiches of schweitzer kaese and rye bread, and drink our lager beer, and we were a nice little family together. Of course, as years have gone by, and the difference in the ages between the students and the professors has increased, that has had to cease. At the end of the first year the question arose, what shall be done with the School of Mines for another year? There was still great uncertainty as to whether it would be a success. You know, there was a mining boom at that time. Every one said that the school would last as long as the mining boom lasted; they did not know that the mining boom was to last forever, so they hardly knew what to do. Some of you may remember that old paper factory, a four-story building on Fiftieth Street; it had been a work-shop for the deaf mutes for years, when the Columbia College buildings were a deaf and dumb asylum, and when the asylum moved away it could not be used for college purposes so it was rented for a wall paper factory, and it had been used for that purpose and was in a very bad condition. The lease ran out at this time, and so

we made bold to suggest that the building be given to us. I carefully examined it and made plans for putting it into condition, to provide assay laboratories in the basement, a qualitative laboratory on the first floor, a quantitative laboratory on the second floor, mineral and metallurgical museum on the third floor, and drawing academy under the roof, we obtained estimates and found it would cost to put it in order some $10,000. The trustees told us to go ahead and have it done, which we did and we then had accommodations for seventy-two students, and, when the term opened, we had eighty-nine, so we had to crowd them in. It was a great success. At the end of the second year came the question "What will you do for the next year?" We hunted about the neighborhood to find another old building, and as we could not find one, we finally made bold to ask for a new building on Fourth Avenue. The trustees said: "We will let you have $30,000." They borrowed all this money. It was borrowed to keep this experiment alive, and to see whether it would be a success or not. We made plans for the building, obtained estimates and found that it could be put up for $30,000; a building 120 feet long, 30 feet wide and four stories high. We did not dare to have an architect because we were afraid he would never be contented to build what we regarded as a suitable building for our laboratories. We wanted a building as large as possible and well ventilated. We knew the architects did not know how to ventilate a laboratory building, and we devised a method of ventilation which I have never seen followed since, but which was a great success. We built flues between the windows; we had the lower ends of the flues open into the laboratories and the upper ends open out-doors in the cornice. Just straight flues on the east and west sides of the building. They laughed and said it will work all right when the wind blows the right way. I said, "Well, the wind can't blow the wrong way on both sides of the building at once. If the wind blows from the east it will come down the flues on that side and ventilate the laboratories and go out on the west side, and if it blows from the west it will come in on that side and go out on the other." We have never had a well-ventilated laboratory since. At the beginning of the third year we were most prosperous, I think we had 120 students, and for the first time we were able to call in a geologist, and dear old "uncle John," John S. Newberry, came, he was a tower of strength and helped us a great deal in various ways. In the first place he

had a great reputation as a geologist and great standing among scientific men, which for us younger men was of great advantage. I must not forget to tell you that the college professors came to the rescue, the moment the School of Mines opened and it was found that there really was a sufficient number of young men of proper equipment to take a course of higher education. Professor Van Amringe, Professor Peck, Professor Joy and Professor Rood said to us "we are at your disposal." And they said "Anything you want us to do to help along, we are willing to do." They came in at once, and, from that day on, they did everything possible to advance the interests of the School of Mines.

And see where it is now. I will not trespass on Mr. Goetze's statistics, but I will just say one thing: there are now in Columbia University nearly a thousand men who really belong to the School of Mines. Where in the world is there a more successful institution of this character in operation! We have all our different mining, metallurgical, engineering and chemical courses, now known as the "Schools of Applied Science." Then there is the architectural department, "School of Fine Arts," which really belongs to us; not only belongs to us but lives with us. It has the upper floor of Havemeyer Hall. Then there is Pure Science. For some reason which I do not know the students who pay especial attention to natural history subjects are supposed to be of more refined etherial character than those who study useful subjects; so we have two faculties, a faculty of pure science and a faculty of applied science. Exactly where the line is drawn between them I have never been able to find out; but the pure science men, are working in our laboratories, studying for Ph.D. They are just as much a part of us as any other students though they are under a different faculty, but not under different professors. All told, our pupils amount to nearly a thousand men. The twenty-four men who came the first day have grown to a thousand, and they are doing splendid work and so have all who have gone before them.

I was in London three years ago and dined with Mr. Ludwig Mond, one of the most distinguished chemical engineers in the world. He is the man who introduced the Solvay alkali process into England, and made such a great success of it, made many other improvements in the chemical industries, and has mining interests all over the world. He is the man who gave a million of dollars to establish the Faraday research labaratory at the Royal

Institution in London. He told me, "Wherever I go in the world the best mining engineers are the Americans. All over the world, and do you know," he said, "the best of them hail from Columbia College." That's the verdict of a German-Englishman, not an American at all, and he most generously paid that tribute to the graduates of the School of Mines of Columbia College. Now, you can imagine what a pleasure it was to me. I told him how it started and how it had grown from nothing, within my recollection, and he was very much impressed. They had a College of Mines in London for a long time, but they never had such success as we had here, because our School of Mines has been eminently practical. We had scientific schools before there was a School of Mines. They had one at Yale and one at Harvard. I went to the Harvard Scientific school, the Lawrence school, in 1853; I wanted to be a chemist. I stayed there a year. There was no organized course of instruction. No plan had been devised for educating a man to be a chemist, and the Lawrence scientific school was not, until recently, much of a success; my friends told me if I wanted to be a chemist I must go to a university in Germany as there was no institution in the United States of America where one could get an education in chemistry. When Egleston and Vinton and I sat down, because we wanted to figure out a course, this is before the School of Mines was started, I insisted that a course of study should be arranged so that every man who followed it would be able to go right out into the world, and find a place and make himself useful, and make a living. It was not to be a place where a man could study by himself some single science which he could use only as a teacher. It was to be a school which would educate professional men, would have a prescribed progressive course of studies so that every graduate of that school would have a distinct calling, a calling that was practical and useful, and one that was demanded by the needs of the country. That was the plan and that is what made the school a success. It was a success from the day it opened, even with the very meager conveniences which we had at our disposal for giving the instruction, and I think the success of the School of Mines is due to the idea on which it was founded. It was to be a professional school, to be a parallel to a law school or a medical school, where a man could get a useful profession, for which the country had a demand, so that he would find his opportuuity as soon as he graduated. It is a great satisfaction to look

back over these forty-five years and see how the young men have come through year after year, determined to take advantage of these opportunities and to make good use of them, and to know that they have gone out into the world and have justified the establishment of the school. There is not a place of any size, in the whole United States, where you cannot find a "School of Mines man," filling an important position. I have taken up a great deal more time than I ought to. I thank you for being so patient.

By Professor Burr:

Mr. Chairman and Alumni of the University: I shall have to disclaim the title your Chairman has given me as I left Troy twenty-four years ago; but I am glad to say he is right in intimating that the way towards the best course in civil engineering in this country points to the mouth of the Hudson and not to the head of navigation of that river. When I look back and realize what was the instruction given when I was a student and when I believe it was conceded that the course in engineering at Troy was the best in this country, and compare it with the work now done at Columbia, it is difficult to appreciate the great advances which have been made. The stimulating advantages of the university environment have been powerful aids in making our courses of engineering study unequalled anywhere else in this country, and second to no others in the world.

I am sure that the handful of earnest men who started the school of mines in the most interesting way of which we have heard from Dr. Chandler, builded better than they knew. I do not suppose it was in their minds at that time that they were doing anything towards establishing engineering study other than mining and yet they laid the foundation of engineering courses, which already (I say it with all due modesty) have added largely to the prestige of Columbia and which will continue to enhance its university strength and standing for all time.

Mr. Chairman, I am not going to take up time which belongs to others by assignment, but I will take the opportunity to express my profound gratification at the dinner of the united alumni of the departments of engineering, architecture and chemistry. I believe there is no other one thing connected with the social relations of alumni which can do so much as these annual gatherings for the welfare of the university as a whole no less than for these

departments. I will even go one step further and say that I have designs in view which in time will need your material assistance. We are endeavoring to do things in the engineering school and we want your assistance. I hope this happy family dinner, as it has been well described by the Chairman, will open the way for some material developments which some of you at least will hear much more about at no distant future date.

By Mr. John B. Pine:

Mr. Chairman and fellow alumni: I am very glad your Chairman has given me this text because there is no subject that has been more in my thoughts for some years past than that of alumni representation and I feel that the establishment of a system by which the alumni are to have a voice in the selection of Trustees marks an event of great importance which will have far-reaching consequences in the history of the university. Probably you are all aware that it marks the accomplishment of a wish which has been strongly felt by our alumni for fifty years. The alumni of Columbia were the first in this country to suggest that they, as the sons of Columbia, should bear at least a share of the responsibility for her maintenance and management. There never has been a time when our alumni have not loyally and earnestly desired to bear that responsibility. During the last fifteen years the Alumni Council has been actively engaged in laying the foundations which would make such representation possible. The scattered residences of our alumni, their lack of organization, were the great difficulties in the way. Then, too, the fact that so many of our alumni are graduates of the professional schools only and have a first and special interest in other colleges presented another serious problem.

In 1895, when the Alumni Council was organized, it set to work to form alumni associations throughout the country on the basis of graduation from the university, irrespective of schools. This was prosecuted vigorously and two years ago we felt that we would be justified in bringing forward a proposition looking toward recognition of the alumni by the trustees. The occasion chosen was the opening of Hamilton Hall, which proved to be the right moment. The trustees were open to the suggestion and took it up in the same spirit in which it was presented, with the result that a plan was prepared by joint committees representing your association and the associations of the College, Law and Medicine. This plan, after conference with a committee of the trustees, was sub-

mitted to the Board and was adopted on December 7 in the form in which it has come before you. We can hardly realize as yet how much it means to us that we alumni are now formally and officially recognized as members of the body corporate, having a right to participate in the selection of the governing body of the university. This is the principle for which we have been contending for years; a principle upon which the oldest universities have been founded. It means much to us to feel that we have this actual part and participation in the control and policy of the university; and it means even more, I think, to the university that the alumni are to have such part in its guidance, that their active interests are to be bound to the university even more closely than heretofore and that it is to have the benefit of their sympathy and close touch with public needs and sentiments.

The plan as adopted differs essentially from that in use at any other university. It was impracticable for us to provide directly for the election of trustees, except by amending the charter of the corporation and the plan of having the alumni nominate was adopted in order to avoid applying to the Legislature for such amendment. It was also decided that in view of the unsatisfactory results which have followed at some other colleges through haphazard methods of selecting trustees by postal-card vote, the selection of trustees should be made by a committee composed of thirty or forty representatives chosen by the different alumni associations, each casting as many votes as the membership of his association numbered. The purpose of this feature of the plan is to secure careful, impartial and intelligent discussion of the qualifications of candidates, in order that men may be chosen for their probable usefulness and effectiveness as trustees and not on account of political prominence or personal popularity. As part of this plan the trustees proposed the feature to which your Chairman referred when he said that it threatened to plunge your association into bankruptcy, referring to contributions to be made annually by each association to the council. I am sure this contribution will be gladly given if you appreciate the important results which it is likely to produce. In undertaking so serious an enterprise President Butler, with his usual foresight, realized that it would impose much more work and responsibility upon the Council as well as greatly increased possibilities of usefulness and he at once provided for the Council an office in the university buildings, to serve also as headquarters

for all the alumni, as a place where all alumni records should be kept and where information as to the alumni could always be obtained. That office is provided by the university without expense, but its maintenance, and the carrying on of its work in the way of correspondence with other associations of alumni, with individual alumni desiring to obtain positions or with schools and colleges which should send us desirable students; correspondence of a wide and varied description, for all this work you can see a considerable income is necessary. The annual meetings of the committee to nominate alumni trustees and the arrangements for these meetings and the continuance and extension of the practice pursued for the last four years of sending a representative throughout the west, always as far as Denver and sometimes as far as San Francisco, which has been of great benefit to the university and a source of much satisfaction to the alumni will also entail considerable expense. This will indicate briefly some of the actual needs of the Council for an assured income.

There are also other conditions arising constantly when it will be of the greatest advantage to the university, and a gratification to the alumni to have the Council, composed of your own representatives, in a financial position to further the interests of the university. For instance, I have in mind such purposes as assisting the classes of 1899 and 1884 in their effort to raise funds to lay out South Field as a foot-ball field, with a running track and base-ball diamond. These classes in a generous and far-seeing spirit have undertaken this work, involving an expense — eight or ten thousand dollars — which is a large sum for a small number of men to assume. If the Council were able to say to these classes, we will contribute one or two or more thousand dollars, the encouragement would be great, and other classes would be led to undertake similar enterprises. If the council were in position to render such assistance in university matters generally, to contribute from time to time to the crew or to some object in which the alumni are particularly interested, the results to the university would be most advantageous. While the sum asked of each individual is insignificant, the aggregate amount in the hands of the Alumni Council can be made a source of increasing strength to the associations and to the university.

I congratulate you again upon the establishment of alumni representation, bringing new life and new enthusiasm to the uni-

versity. This is also President Butler's hope and expectation and, I trust, you all realize that the accomplished fact is due largely to his efforts and to the unfailing support which he has given to the efforts of the alumni.

By Professor Munroe:

Professor Chandler has told us of the early history of the School of Mines. Dean Goetze has spoken of the present and of what is now being done to increase the efficiency of the several schools under his charge. Professor Burr has told us something of our ambitions for the future.

It now remains to add a connecting link between the early history and the present. The School of Mines, and the schools of engineering, chemistry and architecture, which have grown from it, owe much to the constructive ability and devoted service of the small group of professors who were responsible for its organization, and who first made the success of the new undertaking. Others have since contributed their share to the development of the course of instruction. We have had several periods of reorganization like the one outlined by Dean Goetze.

During the past thirty-three years there have been five such. Committees have been appointed, the curriculum has been carefully considered in detail, and each time important changes have been made tending to strengthen and improve the instruction given. In these periods of revision the alumni have been consulted freely and have made valuable suggestions. Twice alumni committees have been formed to consider the organization of the school. These committees each time made careful study of the educational problems before them and contributed elaborate reports of much value. The success of the School of Mines is doubtless due in large measure to these repeated careful and critical examinations of the curriculum and to the helpful coöperation of the alumni therein.

Among those who have exerted an important influence on the policy and traditions of the School of Mines must be mentioned one who joined the faculty at the first of these periods of reorganization, Professor William P. Trowbridge. For fifteen years, from 1877 till his death in 1892, Professor Trowbridge occupied the chair of engineering, and lent his influence to the strengthening and perfecting of this department of instruction. It is to him more than any one else that we owe that emphasis on the mathe-

matical and scientific basis of all engineering, which now characterizes the instruction at Columbia. The single department of Engineering has been divided into four, mining, civil, electrical and mechanical, but in all the influence of Professor Trowbridge and the traditions he established continue to be felt.

The School of Mines has become a group of engineering schools, and it is interesting to note how each new department of instruction as it develops aids and strengthens the instruction in the other departments. The students of mining, for example, have now the advantage of instruction and laboratory work in civil, electrical and mechanical engineering under most favorable conditions as to teachers and laboratory equipment, advantages that they could hardly obtain in a school devoted to mining instruction alone. On the other hand, the department of mining contributes instruction in excavation, boring, shaft sinking, and tunneling for civil engineering students, and the department of metallurgy supplements the training of all engineering students by giving instruction in the manufacture and properties of iron, steel and other metals and alloys which would be difficult to obtain but for the existence of a School of Mines at Columbia.

By Professor Kemp:

A Plan for Improving Conditions in Columbia University.

At the various dinners of the alumni the burden of the speeches always relates to the conditions surrounding the student body. We grow eloquent over the efforts being put forth for the boys, while the only reference to the faculty is to habitually place them "down below where all is woe." It is the subject of the uplift of the faculty, however, which I wish to discuss.

For a long time past I have been impressed with some anomalous features in the social life of Columbia University, and after serious meditation upon the subject, I have concluded to maintain silence no longer but to submit to the alumni of the Schools of Applied Science, and especially to the graduates in architecture, a plan for improvement. We are very much in the position of the shoemaker's children who go unshod — or expressed in another way we are confronted with abundant charity and yet none of it beginning at home — or in still different form we have a dozen or so of preachers and no one of them practicing his doctrines in his own parish. Thus, year after year our professor of sociology discusses the amelioration of conditions downtown, or in the crowded quar-

ters of London, or in Mostar, Herzegovina, but whoever heard him refer to the Columbia faculty and its present disadvantages.

We have, again, several professors of economics and political science, all of whom and with some repetition among themselves, discuss at great length tariff and free trade in China, Thibet and German New Guinea but who never utter a syllable about the principle of protection as applied to their fellow members in the teaching staff. Therefore, as we all know the severity of conditions involving food, lodging, clubs and amusements in this city, I have addressed myself to the problem and I now have the honor to present to this august and influential body the aforesaid plan for betterment.

In order to improve the conditions of living I have passed in review all sorts of schemes. We might consider for example transplanting the teaching staff in a body to the heights of the Palisades in New Jersey, just across the river, and starting a colony in the woods of the neighboring state. One or two of our courageous pioneers have already gone thither and the movement might appeal to our manliness in that it resembles the work of our forefathers who cleared the wilderness. But it has the disadvantage of taking some people to the frontier who are not accustomed to its methods of life. What success, for instance, could my colleague, the professor of dramatic literature, expect to have if he were forced to wield a real ax instead of a figurative one. And how could our grubbers after Greek and Latin roots make headway with those of an oak tree? Worst of all, how could we still maintain existence, even though our physical health were greatly improved, if we were cut off from the life of the metropolis by the waters of the Hudson and nobody knows how many feet of silt and gravel on its bottom.

When we turn to the hills of Westchester the same objections arise, or if we look toward Brooklyn — but of course Brooklyn would not answer.

Therefore Manhattan Island alone remains, and on Manhattan the only available site is the southwest corner of South Field. Therefore, secondly, I propose the erection upon this site of a forty-five story apartment house to be called the Cosmos. With the actual details of size I will not trouble you beyond saying that it should be 150 feet (46.15 meters) square and should have a well or hollow space in the center 50 feet (15.3 meters) square, leaving

thus a hollow rectangle 50 feet (15.3 meters) wide all around. The ceilings should be ten feet (3.07 meters) from the floors, and this height with a one foot (.3 meter) thickness of floors would only call for a building 500 feet (or 153.8 meters) high, a very moderate altitude as buildings now go in this city. There is an excellent rock foundation, a magnificent view, nearness to the university, subway, trolley cars, Pabst's in Harlem — in fact all the advantages one could desire. Into the Cosmos I propose that all the teaching staff of the university and the librarian and president be gathered as a part of the terms of their appointments, and that they be provided with quarters rent-free but in accordance with the following general scheme. In the scheme, the reward of good service is constantly held out in the form of advancement in the social scale. This advancement always upward, takes place with one or two exceptions in a regular and systematic way, and is suitably recognized and recorded in official titles.

At the bottom we should of course begin with the assistants and the necessary space in the form of individual suites of two rooms each should be assigned to them. The senior assistants should have, of course, the outside rooms, and especially those in front. The newly appointed should have the darker rooms opening into the central well. This has the great advantage of making the home surroundings of these young men not too attractive. It is very bad policy to constantly tempt away from their duties those whom the weight and experience of years have not yet steadied into habits of industry. At present I have often observed that the fine views from the windows of Hartley and Livingston lead these young persons to spend too much of the day dreamily puffing a pipe and gazing off into space, without I have felt confident, having their minds fixed on the eternal verities of science or mathematics but presumably on the eternal feminine. If a young and impressionable instructor could look only into a well 500 feet (153.8 meters) deep he would remain by preference at his desk in the laboratory or museum where anxious seekers after knowledge or fossils or minerals could find him.

The official titles of these young persons should also correspond. Thus we would have duly recorded in the catalogue used in our official relations: First-Floor-Back-Entry-Assistant Rogers, Second-Floor-Front-Entry-Assistant Kirk, etc.

As we rise in the scale to the tutor's and instructor's grade, on

the next floors it would be necessary to have larger suites, in fact those of sufficient extent to give each man at least one outside window. Instructors in particular should be provided with suitably commodious and extensive quarters. In official life titles similar to those just mentioned would of course, be employed. Thus, Third Story-One-Front-Window-Tutor Morrison; Third-Story-Two-Front-Windows-Tutor Joüet; Fourth-Story-Two-Back-Windows-Instructor Judd; Fifth-Story-Front-Bay-Window-Instructor Berkey, etc. You all see how it would naturally develop — just like the Mandarin of the yellow button, Cheng Fong Wing, or the Mandarin of the three green buttons and the yellow jacket, Ting Tang Tong. We have abundant familiar precedents.

Next above would come the adjunct-professors with properly expanding accommodations. If you should hear for example, Eighth-Floor-Front-Adjunct-Professor Campbell, you would know at once that said incumbent was in his second year as adjunct-professor and had reached the front apartments. Tenth-Floor-Adjunct-Professor Mayer would imply quite long service.

Next above would come the professors again with expanding quarters and of course with fewer to the floor. Thus if we heard the title Sixteenth-Floor-Five-Back-Windows-and-Portico-Professor Walker, we would know that Professor Walker was new at the business but that he had one of the finest suites assignable under the rules. Twenty-fifth Floor-Southern-Exposure-Professor Peele would imply a moderate number of years but of distinguished service. And so on to the top of the professors' stories.

Now all of these apartments thus far mentioned being assigned by seniority, it would be necessary when anybody was promoted, or died or resigned, to all move up one, two, or five places as the case might be. Within the grades care would be exercised to have the apartment sufficiently similar in size and arrangements to facilitate the removal of furniture, for of course with promotion from a lower grade to a higher every man naturally expands. Statistics show that an assistant has as a rule two ordinary chairs, a morris chair, three sectional book cases, three framed photographs, an iron bed. A tutor adds a rocking chair, two ordinary chairs and three sectional book cases, but usually the framed photographs by some strange process are now reduced to one and almost always the occupant of the frame is a girl. An instructor adds various articles of furniture often including a high chair; an

adjunct-professor still more, while a professor has a notable quantity especially of book cases which he seldom if ever opens. By a little ingenuity a scheme could be readily devised whereby the rooms could be divided off into imaginary squares like a map in an atlas, so that a tag on a chair reading G 12, would enable the skilled force of janitors to put the chair away at once.

There is one additional great advantage in this progressive system of titles which makes them infinitely superior to the one now prevailing. We have as you know the Lieber Professor of History, the Jay Professor of Greek, and others like them. Now, when in the faculty meetings the President calls upon the Lieber Professor of History, it is objectionable for several reasons. In order to have his German correct, the President ought to say "The Lieber Herr Professor," and by not so doing he sets a bad example to those professors who, not being well trained in German, might make the mistake outside. In the second place it draws objectionable comparisons. Why should one individual be the President's or University's one Lieber Professor and all the other be grouped in a bunch not dear to him or it. How much better to say, the Thirty-ninth-Story-Front Professor of History.

Again imagine the distressing experience of our colleague who is addressed month after month and in the most public way, as the Jay Professor. How much better to say, the Fortieth-Story-Front-Corner-Professor of Greek.

There are thus many minor arguments in favor of the plan and others would doubtless occur to one on reflection.

But you will say no mention has been made of the Deans of the several faculties. That is true and at the outset I was much puzzled myself. If they were placed on the floors above the Professors what could we do with them when they resigned and now that so many terms of office are so short how could we provide for them in a plan that is fundamentally progressive. How provide moreover for our numerous Acting Deans. But all these difficulties have recently been dissipated because, as we all know, the Deans, like the snakes in Ireland have begun to swallow each other, and in a year or two there will not be any at all.

The Theodore Roosevelt Professors on their return ought however to have the forty-first floor and with them should be quartered the Kaiser Wilhelm Professor in a fine and suitable suite, the best the university could provide. Somewhere in this region should be

the Librarian. I have hardly known where to classify him, but then, for that matter, neither did the President and the Trustees for quite a good many years.

Next above should naturally be placed the President with the entire front of the house and so much of the sides as might be necessary. In the rear might be placed the Secretary of the University.

There remain still two or three stories, and these are of course to be reserved for those venerable men of emeritus grade who have retired on the Carnegie foundation. At present they are forced to seek the fresh air, fine views and reduced rents of the country. But in the upper stories of the Cosmos they would have all the fresh air and the views without any rent whatever. It is but proper to recognize long service by assigning to these officers the most desirable quarters in the entire structure. Besides this arrangement leads naturally to the final feature in the plan. I am led to suggest this feature by three important considerations. First, from deep interest in the work of my colleagues in archeology Egbert, Wheeler and Gottheil, I desire to see their successors a few millenniums hence provided with good and significant records for the study and reproduction of these times. The records should take the forms with which archeologists are generally familiar and which they understand. Second, I have often been impressed as I have walked round and round this campus with the anomalous condition that now prevails, in that we have a long row of cinerary urns and not a sinner in them. Third, all the philanthropists and benefactors of to-day have been so exclusively wrapped up in aiding people to live that they have overlooked the extremely serious situation which arises when a man in New York is confronted with the bills for his funeral and interment. Cemeteries are fearfully expensive things and there is no Carnegie foundation on which we may fall back. Therefore I propose that every person on accepting an appointment in Columbia University should express his or her approval of cremation. A crematory should then be constructed on the roof of the Cosmos Building to which all should naturally come. The department of metallurgy should be requested to compound an absolutely resistant and indestructible alloy, such as phosphomolybdenum bronze or several others which will occur to some of you. From these suitable cylinders can be prepared with caps that screw tightly on. Upon the outside is to

be engraved a sketch of the life and service of him whose ashes repose within. The inscription should be so expressed as to throw light on the history of the times.

I propose to recompense the Department of Metallurgy for their invention by turning over to them all the gold and platinum which would be caught in the crematory furnace from the fillings of teeth, etc.

The cylinders are then to be stored away as follows: Presidential ashes in the bowls of the fountains in front of the university; Theodore Roosevelt professors and librarians in the urns on 116th St.; professors and adjunct-professors in the urns on Amsterdam Avenue and Broadway; and instructors in the urns on 120th St. Holes are to be drilled in the granite and the cylinders, which would be naturally about a foot long by an inch in diameter, will be hermetically sealed therein by some indestructible cement. The funeral services will be simple. For presidential funerals all the staff will be ordered out. For others only their colleagues in rank. They will march in gowns and with hoods either inside out, or upside down, like reversed muskets, and the Chaplain will perform a service like laying a corner stone on a small scale.

But some one remarks what about the ashes of the tutors and assistants. Well that does not seem to me a very serious question, but I would suggest that they be strewn on the grass of the campus, so that after decease everybody could continue to walk all over them, just as has always been the case in life.

By Professor Hamlin:

Mr. Chairman and friends: I don't quite know in what capacity I ought to consider myself to be present; whether as the returned prodigal, or the rank outsider. In either case I have certainly been treated like a welcome guest. When Dr. Chandler narrated the small beginnings of the school, it reminded me of our small beginnings in the school of architecture. There were four students who started that school and they have grown to 120 or 130, so our proportion to the increase of Dr. Chandler's class holds fairly well. We have reached a result that is very satisfactory to us. We have plans also, as Dean Goetze and as Professor Burr have intimated they have; plans for the future development of the school of architecture. Among other things we hope to establish a school of landscape architecture and engineering, in which we shall enter anew into close relations with the Schools of Applied Science. These

plans are tentative as yet, but we indulge the hope that they will some day be realized. We have also planned the reorganization of an elective course in architectural engineering; but I will not take up your time at this late hour in telling you of the changes that have been brought about in the organization and administration of the school. This fact is, however, worthy of remark: In general the course of instruction outlined and inaugurated by Professor Ware still supplies a training adequate as far as the present conditions of the profession require; not one subject which he put into the curriculum has been dropped, and not one subject added to those he conceived to be necessary. Methods of teaching and the emphasis on certain subjects have changed, but not the subjects themselves. It is a remarkable proof of far sightedness in Professor Ware that after 27 years of experience his original plan should still be the working plan of the school of architecture. I thank you very much for this opportunity to express my appreciation of the fact that we are still remembered as associated with the alumni of the schools of mines, engineering and chemistry, and I trust that the relations which keep us in touch with that part of the university will never be diminished or weakened.

ABSTRACTS — ANALYTICAL CHEMISTRY.

By E. WALLER.

Asbestos. (*Analyst*, XXXIV., 9.) In a discussion in the Soc. Pub. Anal. on certain methods of analysis, the point was made that but few if any samples of asbestos were sufficiently insoluble in mineral acids to be used in filtering without some correction, where the filter was afterward to be weighed.

Quick Mode of Decomposing Minerals. Pollard (*Chem. News*, XCVIII., 211). Mix one part of the pulverized substance with one part of vaseline and 5 parts Na_2O_2. Place the mass in a scorifier or on a thick iron plate and ignite with a match. On cooling extract with water. The method is particularly suited for qualitative tests when in the field.

Standard Hydrochloric Acid Solutions. Hulett and Bonner (*J. Am. Chem. Soc.*, XXXI., 390). A "constant boiling" HCl is capable of use as a basis for volumetric work. Starting with an acid of almost any strength, and distilling — a point is soon reached where the degree of acidity in the retort and that condensed holds the same strength of acid. At 760 mm. pressure the density (at 25° C.) is 1.0962 and the strength 20.242 per cent. HCl, or 180.17 gms. of distillate will contain 36.47 gms. HCl. The boiling point is 108.54° C. The variations due to variations of barometric pressure likely to be encountered are not very great. The table given is:

Bar. Pressure.	Per Cent. HCl.	Gms. for 1 Mol. HCl.
770	20.218	180.390
760	20.242	180.170
750	20.266	179.960
740	20.290	179.745
730	20.314	179.530

Starting with an acid of sp. gr. 1.10 after distilling over three fourths the succeeding distillate will not vary over 1 part in 1,000 from the above figures.

Sensitive Indicator. Rupp and Loose (*Ber.*, XCI. 3905). The indicator is superior to hæmatoxylin or iodœosin for use with dilute solutions (centinormal, etc.) or with weak bases (*e. g.*, some alkaloids). The color in alkaline or neutral color is pale yellow, the acid color violet red. The short name assigned to it is "methyl red," the full name is para-di-methyl-amino-azo-benzene-ortho-carboxylic acid.

Potassium as Phosphomolybdate. Schlicht (*Chem. Ztg.*, XXXII., 1125 and 1138). The reagent is prepared thus: Dissolve together 100 gms. MoO_3 and 250 gms. crystallized Na_2CO_3, evaporate to dryness and heat 2 hours at 150° C. Take up with water and dilute to 500 c.c. Meantime dissolve 6 gms. $Mg_2P_2O_7$ in boiling aqua regia and evaporate repeatedly to remove Cl. Finally dissolve in water with a little HNO_3

(Gr. 1.36) and dilute to 500 c.c. with the same acid. Mix this (slowly and with stirring) with the MoO_3 solution — add 500 c.c. of water — let stand 2 hours, and filter.

To a solution containing as much K as corresponds to 0.1 gm. K_2SO_4, add 10 c.c. of the reagent — evaporate to dryness, take up with 10 c.c. of hot solution of 5 per cent. $MgSO_4$, and when cold filter on a weighed asbestos filter, washing first with 10 c.c. afterward 5 c.c. of 5 per cent. $MgSO_4$, then three times with 5 c.c. of 5 per cent. NH_4NO_3, finally with alcohol and ether. Dry and weigh — ignite and weigh again. 0.1 gm. K_2SO_4 yields 0.8071 gm. dry, and 0.7860 gm. ignited.

Commercial Lime. Popel (*Zts. angew. Chem.*, XXI., 2089). A solution of NH_4Cl is poured over a weighed amount of the lime in a flask, and the NH_3 distilled over into standard H_2SO_4 which is afterward titrated, Nowicki (*ib.*, 2318) remarks that $CaCO_3$ will also afford NH_3 under these conditions.

Solubility of Lime in Water. Moody and Leyson (*J. Lond. Chem. Soc.*, XCIII., 1767). The solubility of CaO [$Ca(OH)_2$] seems to be variable. Investigation showed that: (1) lime water only becomes saturated after long contact with excess of lime; (2) a saturated solution becomes supersaturated on raising the temperature, the excess separating very slowly; (3) filtering through paper or other fibrous material weakens lime water; (4) chlorides adhere obstinately to lime — if the Cl is driven out by strong ignition, a pure lime may be obtained; (5) lime prepared by igniting $CaCO_3$ precipitated by the use of fixed alkali carbonates gives a solution of greater alkalinity than that from pure calcite owing to the retention of small amounts of the alkali.

A table of solubilities of CaO at different temperatures is given, in terms of the weight of water necessary to dissolve 1 gm. CaO.

At 2° C. it requires 768.5 gms., at 80° 1368.1 gms. — nearly twice as much.

Barium — Volumetric. Hill and Zink (*J. Am. Chem. Soc.*, XXXI., 43). The method consists in precipitating as $Ba(IO_3)_2$ dissolving, and then titrating with standard $Na_2S_2O_3$. With a sufficient excess of KIO_3 in the solution the precipitation is practically complete.

The details are: Take an amount of the solution containing approximately 0.1 gm. Ba, render neutral or faintly alkaline with NH_4OH (free from carbonate) make the volume up to about 60 or 70 c.c. Then add slowly of N/6 KIO_3 (about 36 gms. per liter) in quantity sufficient to give about 25 c.c. in excess, stirring briskly during the addition, and for a minute or so more. Allow to stand 5 minutes. Filter, and use some of the filtrate in transferring the precipitate to the paper. Wash three times with strong NH_4OH, and then three or four times with 95 per cent. alcohol. Rinse the precipitate into an Erlenmeyer flask, throw in the filter paper, add 50 c.c. of 10 per cent. KI (free from KIO_3 or in which the KIO_3 has been determined). Add also 10 c.c. conc. HCl, stopper, and allow to stand 5 minutes with occasional shaking. Then titrate with standard $Na_2S_2O_3$ solution (N/10 strength).

Na salts cause but little interference. K, NH_4 or Mg salts are likely to cause occlusion of KIO_3 in the precipitate unless the precipitation is

effected in hot solution. Ca and Sr are inadmissible since they are also partially precipitated as iodates.

Ferrous Iron in Minerals. Gage (*J. Am. Chem. Soc.*, XXXI., 381). Decomposition of the mineral with the aid of HF and heat is readily accomplished, but the HF interferes very decidedly with the permanganate titration. To expel it requires much time with great danger of oxidation of the FeO. The author has found that the interference may be obviated by addition of calcium phosphate just before titration. The calcium phosphate solution is prepared by suspending 5 gms. $CaCO_3$ in 50 c.c. of water, and adding 10 c.c. (85 per cent.) of orthophosphoric acid slowly with stirring. This amount was found to suffice in the treatment of 0.5 gm. of magnetite. 0.5 gm. of the magnetite or other mineral is to be weighed out in a 50 c.c. platinum crucible, moistened with water, coils of fine Pt wire introduced to prevent bumping and then a cold mixture of 10 c.c. HF and 15 c.c. of H_2SO_4 (1:3) is added. The close fitting cover is then put on, and the crucible placed in a hole in an asbestos board, which is of such size that the crucible rests in it when about half way down, fitting closely. Over this is put a 6-inch paraffined funnel the stem of which is connected with a CO_2 apparatus. The rim of the funnel should fit closely against the asbestos board. Pass in a strong stream of CO_2, and in a few minutes apply the heat of a burner to the crucible regulating it so as to quickly bring the contents to boiling and after that to keep them boiling gently. Apparently the point at which the treatment can be safely stopped must be judged by experience; ordinary rocks require about 5 minutes. Magnetite, etc., may require a little longer. Remove the burner, and when the steam has condensed lift the crucible (still covered) by the aid of a loop of stout Pt wire (previously adjusted) and plunge it at once in 400 to 500 c.c. of cold water in a beaker. When ready to titrate upset the crucible in the beaker, stir, then add the calcium phosphate solution, and proceed to titrate. The first permanent color is to be taken as the end point, though it may fade in a short time. A blank determination should be run, and the corresponding correction made.

Titanium — Volumetric. Eva Hibbert (*J. S. C. I.*, XXVIII., 189). An Erlenmeyer flask is fitted with a three hole cork. The center hole carries a Bunsen valve through which passes a stout platinum wire, to the lower end of which is attached a piece of zinc. The other two holes carry bits of glass rod as stoppers, to be replaced by tubes during the progress of the work. A solution containing the Ti is placed in the flask, some HCl is added, and the piece of zinc is lowered into the liquid by means of the platinum wire after adjusting the cork. When reduction has proceeded for 15 to 20 minutes, and the solution has been boiled, one of the rods is removed and replaced by a tube through which CO_2 is delivered into the flask. The Zn is then raised out of the liquid, washed off with a little boiled water, and through the other hole in the cork, is run a standardized solution of methylene blue from a burette so long as it is decolorized. $FeCl_3$ has no reducing action on the methylene blue, but in presence of much Fe the preliminary reduction with the Zn must be kept up longer to effect complete reduction.

For ores containing Ti fuse with about 10 times as much KOH in a nickel dish, treat with water, acidify with HCl, and proceed as above. By titrating Fe in one portion of an ore with $TiCl_3$ using NH_4CNS as indicator (titrate to decolorization), and in another portion applying the above process both Fe and Ti may be determined.

The process of Newton (*Zts. anorg. Chem.*, LVII., 278) is only applicable when no Fe accompanies the Ti. It consists in reducing hot by Zn, cooling in an atmosphere of H, adding a solution of $Fe_2(SO_4)_3$ and titrating with permanganate the ferrous Fe reduced by the titanous compound. The iron standard divided by 0.689 gives the Ti standard.

Separating Cerium, etc. Dittrich (*Ber.*, XLI., 4373). In presence of ferric salts, all the Ce is not precipitated by $H_2C_2O_4$, and moreover if a ferric salt is added some of the Ce goes back into solution. It is only when a large excess of $(NH_4)_2C_2O_4$ has been added — sufficient to form complex ferric oxalates, with all the Fe present — that complete precipitation of Ce can be effected. An exceedingly large amount is necessary, *e. g.*, with 0.2 gm. cerium sulfate, and 15 c.c. of a concentrated ferric salt, some 200 c.c. of saturated solution of $(NH_4)_2C_2O_4$ are necessary. Precipitate hot, and allow to stand some time before filtering.

Tantalum, Niobium and Titanium. Giles (*Chem. News*, CXIX., 25). To open up columbite and similar minerals containing these elements, the author finds the best method to be fusion with K_2CO_3 at a high heat in a reducing atmosphere. Steel crucibles are used which are placed inside of graphite crucibles and the space between is packed with powdered charcoal, the top and cover being covered over with somewhat larger bits of charcoal. A rather moderate heat is applied at first to frit the materials and to allow the most of the CO_2 to escape while the mass is still porous. The heat is then raised and maintained at the highest temperature the furnace will give for an hour. A Griffin radial burner gas furnace was used.

On treating with water potassium tantalate and niobate pass readily into the solution, while only traces of other metals (FeMn, etc.) will be dissolved. The detail of the further treatment should be sought in the original paper.

Copper in Ores—Volumetric. Hawley (*Eng. & Min. J.*, 1908, LXXX., 1155). Treat 0.5 gm. or more of the ore with H_2SO_4 and HNO_3 (1:3) and boil down to dense fumes of SO_3. Cool, dilute to about 35 c.c., and just neutralize with NH_4OH, then add 4 c.c. HCl, and 10 c.c. of a 20 per cent. solution of Na_2SO_3. Boil, and precipitate Cu by 5 c.c. of 4 per cent. KCNS. Boil a few minutes longer — allow to stand 5 minutes, and then filter, washing with hot (not boiling) water. Pour through the filter a boiling 6 per cent. solution of NaOH, which afford NaCNS and $Cu(OH)_2$. Wash well, and after acidifying the solution and washings with H_2SO_4, titrate with standard permanganate. The Fe value × 0.197 gives the Cu value.

An allowance of 0.0025 gm. Cu should be added to the Cu found. The whole operation requires about 30 minutes and 20 determinations can be completed in an hour and a half. With careful work the results will agree with the electrolytic method within 0.04 per cent.

Separating Tungstic Acid from Silica. Nicolardot (*C. Rend.*, CXLVII., 795). By heating the material in a current of air and chloroform vapor to 500° the W is vaporized off as a mixture of oxychlorides, and condensed in a suitable receiver.

Tin Oxide. Dott (*Pharm. J.*, LXXXI., 585). 0.15 gm. of SnO_2 when heated with 0.5 gm. hypophosphorous acid for 30 minutes is converted to the stannous form, and becomes readily soluble in HCl. SiO_2 is unaffected by this treatment and can be filtered off clean.

Separating Tin and Antimony. McCay (*J. Am. Chem. Soc.*, XXXI., 373). The author finds that Sb may be completely separated from Sn in a moderately dilute solution of a mixture of the two when a decided excess of HF is present (5 c.c. of a 48 per cent. acid in 300 c.c. of the mixture) and a large excess of $NaC_2H_3O_2$ has been added, provided that the Sb is present in antimonious, and the tin in stannic condition. Paraffined glassware is of course necessary for the H_2S delivery tube, funnels, etc., though for containers (substitutes for beakers) he found cut off ceresine HF bottles preferable. From the filtrate the HF was expelled by adding H_2SO_4 and heating for some time on the water-bath in a platinum dish.

Antimony in Ores. Coolbaugh and Betterton (*Min. World*, Oct., 1908, p. 606). Fuse 1 gm. with 8 to 10 gms. $(NH_4)_2S_2O_8$ (persulphate). Extract the melt with 20 c.c. HCl (1 : 1), dilute to 100 c.c., warm and pass a rapid current of H_2S for 15 minutes. If Cu is present, the precipitate should be treated with Na_2S at this point and reprecipitated; Pb, Bi, or As do not interfere. Dissolve the Sb_2S_3 in 40 c.c. conc. HCl, adding a little $KClO_3$ to oxidize the As. Filter off any separated S and add a few drops $FeCl_3$ solution as indicator. Then run in $SnCl_2$ solution drop by drop. The temperature should be about 90° C. All the Sb is reduced before the ferric color is removed. When decolorized, at once add 10 c.c. $HgCl_2$, dilute to 500 c.c., and titrate with permanganate.

It is well to have two $SnCl_2$ solutions, one strong and one weak, the latter for finishing closely.

Halogen Precipitations. Alefeld (*Zts. anal. Chem.*, XLVIII., 79). The addition of about 5 c.c. of ether to the solution previous to adding $AgNO_3$ and swirling about, will give clear filtrates, especially if the filter is moistened with ether and warmed.

Chlorates. Gartenmeister (*Chem. Zeit.*, XXXI., 174, and XXXII., 677; also Carlson and Gelhaar, *ib.*, XXXII., 604 and 633). Chlorates prepared by electrolytic processes always contain some of the lower oxides of chlorine, which are often the cause of spontaneous or premature explosions of pyrotechnic mixtures. Test by making a saturated aqueous solution of the sample. In 25 c.c. of this dissolve a small crystal of KI, and add a few drops of starch solution. Hypochlorite if present will give a blue without acidification. If chlorite only is present, a blue will be seen on adding 10 drops of H_2SO_4 and stirring in. When hypochlorite is present the blue caused by it at first may be bleached (even titrated) by cautious addition of a little of very dilute $Na_2S_2O_3$ before acidifying. In this way the presence of both may be

shown in the same solution. Carlson and Gelhaar (*ib.*, XXXII., 1151) dispute the conclusions reached by Gartenmeister.

Sulfides, Polysulfides, Hyposulfites, etc., in the Same Solution. Dhuique Mayer (*Chem. Centr.*, 1908, II., 1124). Dilute 10 c.c. of the solution to 100 c.c. and of this dilute 10 c.c. to 200 c.c., and titrate with N/10 H_2SO_4 with phenolphthalein indicator (A). Titrate this with N/10 I solution and starch indicator (I). Decolorize with a minute drop of the original solution, and titrate with N/10 NaOH (R). Dilute another 10 c.c. of the original, shake with 2 gms. $PbCO_3$, and titrate the filtrate with N/10 I(H).

A = sulfides. R = total NaHS.

R — A = true NaHS. I — 2R = polysulfide and hyposulfite.

H = hyposulfite. (I — 2R) — H = polysulfide.

In the case of polysulfides divide the titer by 2 and calculate as Na_2S_2.

Phosphoric Acid — Colorimetric. Pouget and Chouchak (*Bull. Soc. Chim.*, V., 104). A clouding and more or less intense coloration results on the addition of a molybdate together with a solution of strychnia to a solution containing a phosphate. The depth and intensity of color depends upon the relative proportions present of the substances taking part in the reaction. The reagent is made by preparing a 15 per cent. solution of Na_2MoO_4.

To 10 c.c. of this solution add 2.5 c.c. HNO_3 and then 1 c.c. cold saturated solution of strychnia sulphate. Filter if necessary. The mixture turns yellow by standing, so should be freshly prepared when used for quantitative estimations, though it may serve even when colored for qualitative work. Acidify the solution to be tested with HNO_3 and add 2 c.c. of the above reagent. The coloration may be compared with that obtained on solutions containing known amounts of phosphate. Allow to stand 20 to 25 minutes. Sentitiveness 1 in 20 million.

Carbon — Determinations. Ruppel (*J. Ind. Eng. Chem.*, I., 184). The author describes the construction of a Shimer crucible of nickel. The crucible itself, which will ordinarily last for from 30 to 40 determinations, costs $1.10. The water-jacket arrangement, which lasts indefinitely and will fit any and all crucibles of the same model, costs about $7.00.

Decomposing Ferro-Silicon. Nicolardot (*C. Rend.*, CXLVII., 676). The author has found that the decomposition can be readily effected by heating with sulfur chloride to 70°. The operation is performed in a 250 c.c. flask, closed by a dropping funnel of special shape. About 2 c.c. of the S_2Cl_2 suffices for 0.5 gm. of ferro-silicon. The reaction needs only heating to start the action. When complete a few drops of NH_4OH are cautiously let into the flask which is afterward cooled and filled up with water. The contents of the flask are then transferred, and the analysis conducted in the ordinary manner.

Nitrates in Colored Waters. Syme (*J. Ind. Eng. Chem.*, I., 788). In applying the phenolsulfonic process to waters colored with organic matter, the coloration interferes sadly with the colorimetric readings. The author destroys this interference by this treatment. A convenient quantity (say 50 c.c.) of the water is heated to 60° C. or 70° C., and

1 c.c. H_2SO_4 (1:5) is added. Dilute permanganate is then added (a few drops at a time) until in excess, the sample being meantime heated on the water-bath for 15 minutes. Then filter, neutralize with Na_2CO_3 and evaporate to dryness as usual in a porcelain dish conducting the remainder of the operation in the usual manner. It was found by experiment that the permanganate does not form any nitrate from the organic matter when used in this way. Nitrites if present are oxidized to nitrates, and in such cases they should be determined by the sulfanilic test, and the correction applied.

Portland Cement Analysis. Dementieff (*J. Soc. phys. Chim. Russ.*, XXXVIII., 1082). The cement must be pulverized exceedingly fine, and then on digestion with diluted HCl, SiO_2 and all can be brought into solution. If the HCl is of known strength some constituents can be determined by titrating back with normal NaOH. Without adding an indicator run in normal NaOH until the solution clouds: This indicates the amount of excess of HCl used. Add phenolphthalein and then run in N/NaOH to coloration: this gives $Al_2O_3 + Fe_2O_3$ (filter off and determine Fe_2O_3 in the precipitate by the usual method: reduction and permanganate titration). On heating the clear solution the phenolphthalein coloration slowly disappears; continue adding the NaOH until the color is permanent while hot; the amount of NaOH so used, when doubled, corresponds to the MgO present. The reaction is explained by the author as due to the gradual formation of $3MgO.SiO_2$ which separates on heating. Under these conditions where there is not sufficient SiO_2 to combine with both CaO and MgO, the latter combines preferably with the SiO_2.

BOOK REVIEWS.

Untechnical Addresses on Technical Subjects. By JAMES DOUGLAS, LL.D. Second edition with additional addresses. New York, John Wiley & Sons, 1908. 12mo, pp. v × 164. Cloth, $1.00.

The first edition of this little book which appeared in 1904 presented three papers entitled, "The Characteristics and Conditions of the Technical Progress of the Nineteenth Century," "The Developments of American Mining and Metallurgy, and the Equipments of a Training School," and "Wastes in Mining and Metallurgy."

In the second edition which is now before us, are two additional papers, "Some of the Relations of Railway Transportation in the United States to Mining and Metallurgy" and "Secrecy in the Arts."

All of these papers are reprints of addresses delivered at different times by Dr. Douglas, and present facts and figures in regard to mining, metallurgical, and engineering progress in this country in a most attractive form.

The author shows that during the past sixty-seven years the railroad mileage in the United States has increased in direct proportion to the production of pig iron. He also states, however, that during the last twenty years the ratio of the consumption of copper to that of iron has steadily increased which is explained by the use of copper in architecture and electricity. Again using iron as a standard, the consumption of lead has decreased, while zinc has maintained a very steady ratio.

The influence of the railroads on the progress of mining and metallurgy is fully considered, and their importance in the development of the latter recognized.

In the last paper, "Secrecy in the Arts," Dr. Douglas makes a strong appeal for the bars to be taken down at all plants and for a free and full interchange of ideas. In taking this stand, he shows the advantages which manufacturers gain by so doing, and the stagnation which results when works build a wall around themselves which wall has a greater tendency to keep out ideas which might be beneficial than to keep others from knowing what is inside. A majority of the metallurgical profession will agree with Dr. Douglas' opinion on this subject.

The large amount of general information given is put before us in such a way that to read it, is a pleasure rather than a task. The book is well printed and is of such size as to be very convenient.

A. L. W.

A Manual of Practical Assaying. By the late H. VAN F. FURMAN, E.M. Sixth edition, revised and enlarged. By WILLIAM D. PARDOE, A.M., assistant in mineralogy, Princeton University. New York, John Wiley and Sons, 1908. 8vo, pp. xi × 497. Price, $3.00.

Furman's book has been so well and favorably known for over a decade that a detailed review would be superfluous. At the time of its

inception it was probably the foremost book of the type in the United States, being very generally used in institutions of instruction and by the technical profession.

The revisor states that this edition has been thoroughly revised and brought up to date, but as eighty to ninety per cent. of the fifth edition appears *verbatim*, this statement seems questionable. The fifth edition appeared in 1899 and differs very little from the fourth edition of 1896. In fact, the book is replete with statements which, while true, or acceptable at time of original publication, are no longer tenable.

Some portions of the previous edition have been well omitted and valuable substitutions made from standard works such as Low's "Technical Methods of Ore Analysis," and results of investigating committees on methods of analysis, while other matter included does not represent the latest practice.

Chapters have been added on the assay of telluride ores, tungsten, molybdenum and vanadium. Data on these methods has been collected from various sources and combined in some cases without a thorough understanding of the subject.

There is some significance in the fact that four editions appeared from 1893 to 1896, while the present edition is the second within the past twelve years.

Furman's book takes up subjects which to-day would be treated in three or four separate publications, by different authors, and there are very few men who are capable of thoroughly revising this work. With his apparent lack of experience, I think Mr. Pardoe has made a mistake, detrimental to himself and the author's good name, in attempting to put a book of the past in a class with our modern books. This is not to say that the book has no merit, as it contains many useful methods, but to accept it as standard would be to admit that assaying has not progressed. E. J. HALL.

A Study of Ore Deposits for the Practical Miner. By J. P. WALLACE, M.D. New York, Hill Publishing Company, 1908. Pp. 349. $3.00.

This book is intended by the author "for the average miner, the prospector and the mining public." It is considered necessary therefore to include many subjects in an introductory way that are seldom found in a treatise on ore deposits. For example there is a chapter on the properties of minerals, seven descriptive chapters on the ores of the metals treated as minerals rather than as deposits, two on rock-forming minerals, two on rock description and classification, and two on rock structures. These subjects are usually assumed to be understood. Their prominence in this volume emphasizes the elementary side of the subject and no doubt brings the treatment within reach of a large class of men with a deep interest in such questions but with limited training in the fundamental and underlying principles of mineralogy and geology.

Some attention is also given to mine valuation, the value of prospects, and other related matters. In these chapters, the author has gathered much valuable advice of a sort that too seldom reaches the untrained investor or enthusiast.

Treatment of ore deposits proper is included in Parts III. and IV., pp. 153–285. Part III. gives general characters and classes of ore deposits and explains the occurrences and origin of the recognized types. This is followed in Part IV. by a series of descriptions of well-selected mines or districts. A few headings will illustrate the method followed, for example, "The Mother Lode of California: A Zone of Gold-bearing Fissure Veins," "South African Gold Mines: Gold-bearing Conglomerate Beds," "Bisbee, Arizona, Copper Deposits: Irregular Bodies in Limestone — Replacement and Secondary Enrichment."

The descriptions are generally good. The method and material are pretty well adapted to the object in mind. The cases chosen are illustrative with no attempt to be exhaustive. There is nothing new for the professional or trained man, but because of the general soundness of the treatment and rather successful attempt to introduce many fundamental explanatory features, the book is a welcome addition to the not very large list of books on the general subject of ore deposits.

CHARLES P. BERKEY.

The Design of Highway Bridges. By MILO S. KETCHUM, C.E., Dean of the College of Engineering and Professor of Civil Engineering in the University of Colorado. New York City, Engineering News Publishing Co. Pp. xxi + 544. $4.00 net.

This is the most recent contribution to engineering literature from the pen of Dean Ketchum, and has for its purpose the presentation in outline of the calculation of stresses in bridge trusses, together with a more exhaustive treatment of the design and details of highway bridges. Supplementary to his treatise on the "Design of Steel Mill Buildings," it is essentially the same presentation as that given to his students in a first course in bridge design, at the University of Colorado.

Appreciating the abundance of data at hand on various types of railway bridges and the lack of the same for highway structures, the author has undertaken the compilation of the present volume to rectify in a measure this need. Both the analytic and graphic methods are described and numerous problems presented for illustration and solution.

The work is divided into three principal parts as follows:

Part I., "Stresses in Steel Bridges," which contains nine chapters and 188 pages.

Part II., "The Design of Highway Bridges," divided into eleven chapters and containing 243 pages.

Part III., "A Problem in Highway Bridge Details," containing two chapters and 77 pages, an appendix of 27 pages on general specifications for steel highway bridges with index, and a general index of eight pages are also added.

Part I. contains a valuable chapter on loads and weights of highway bridges, together with several others on the methods, both analytic and graphic, of calculating stresses in framed structures, beams, highway and railway bridges, and in their various systems of bracing. The last chapter in this portion contains twenty-four typical problems, solutions for which are indicated by both methods and are, from the student's standpoint, extremely valuable.

Part II. treats not only of steel bridges but combination, timber, masonry and reinforced concrete bridges. In consequence of this, the author attempts to give the theory of masonry arches, abutments, piers, culverts, etc., which properly belong to the subjects of masonry, foundations, retaining walls, etc., although they are admittedly problems that are met with in practice by the bridge engineer. It would seem that the treatment in this regard, because of the limitations of space, is too brief and it is questionable at best, if they deserve place in a work of bridge design.

Part III., dealing with the problem in highway bridge details, is to be commended as it requires a student by a more or less critical investigation of the structure presented, to familiarize himself with the design, detail and calculation of stresses. On the whole the book may be said to contain much that is valuable to both the student and the engineer.

C. E. M.

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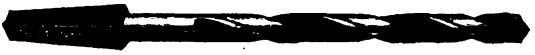

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BENJAMIN BOWDEN LAWRENCE

SCHOOL of MINES, CLASS of '78

THE

SCHOOL OF MINES QUARTERLY.

VOL. XXX. JULY, 1909. No. 4.

BENJAMIN BOWDEN LAWRENCE, E.M.,

FIRST ALUMNI TRUSTEE.

The election of Mr. Lawrence to the board of trustees of Columbia University consummates a desire that the alumni have entertained for very many years, and in a fortunate manner carries out plans formulated by the trustees, president and alumni council during the latter part of 1908. These plans are the result of frequent agitation and long discussions in the past in regard to alumni representation on the board of trustees. In connection with the nomination and election of the first alumni trustee, the hearty cooperation of the various alumni associations and the alumni council has been most gratifying and the care exercised in making the final selection has resulted in placing a man in the office who by education, experience and temperament is admirably fitted to fill it in a manner which will result in great benefit to the University and reflect credit on himself.

Mr. Lawrence who was born in New York in September, 1857, is the son of James Ricketts Lawrence, of New York, and Selina M. Richards, of Philadelphia, his ancestry being English on his father's side and Quaker on his mother's. In Revolutionary times his family on both sides was represented by many prominent men in the army and in Congress.

His early school days were spent with Dr. Hobbes, in the old University Building in Washington Square, and when somewhat older he went abroad and studied for three years in schools in France and Switzerland for the purpose of acquiring French and German. On returning to America he attended Grammar School

No. 35 where he completed the course in 1872. A short time afterwards he entered the Columbia School of Mines, and was graduated in 1878 as a mining engineer.

While at college Mr. Lawrence took a prominent part in athletics. He was on the foot-ball team in the first games played under the so-called Rugby rules, a substitute on the base-ball team covering second base on several occasions in regular games, and rowed in the eight-oared barge races. The interest he then took in all sports has continued and he has always been an ardent supporter of Columbia on land and water.

After graduation he was engaged a few months as engineer for a firm of New York contractors and then went west to take up actively his profession of mining engineering. His first position was in October, 1879, as superintendent of the Montezuma Mining Company situated in the isolated camp of Montezuma, at an altitude of 10,000 feet, in Summit County, Colorado, and separated by the Argentine Pass from the nearest railroad facilities at Georgetown. The place was difficult of access in summer and absolutely cut off from the outside world in winter by the snow. Mr. Lawrence looks back on this experience as having enabled him to acquire the gentle art of cooking his own meals and after much suffering to learn as he would have learned in no other way the proper means of taking care of his physical needs. In 1880 he was joined by his classmate Richard A. Parker, and together they managed the household. About fifty men were employed at the mine and it was here that Mr. Lawrence installed the first air drills operated in Colorado. He remained in this part of Colorado for more than five years working in Leadville, Breckenridge and adjacent camps, after which he returned east.

On his arrival in New York in 1885 he associated himself with William A. Hooker, a graduate of the class of 1869, School of Mines, establishing the firm of Hooker and Lawrence, consulting mining engineers, with offices in 145 Broadway and during the next two years examined many well known properties, among them being the celebrated Horn Silver Mine in Utah.

Mr. Lawrence returned to Colorado in 1887 to act as superintendent of the Mayflower Mine, Idaho Springs, and a year later became manager and lessee of the Dives-Pelican Mine in Georgetown with which property he was actively connected for the next ten years.

He then devoted his time to consulting mining engineering work, having headquarters in Denver, and from 1898 till 1901 examined mining properties throughout the west and Mexico. It was during this period that he acted as consulting engineer for the Portland and several other mines at Cripple Creek. He was also president of the Smuggler Union Mining Co. at the time this company was involved in the fight with the Western Federation Miners' Union. In the course of this struggle Mr. Lawrence saw his general manager, Arthur Collins, killed by the members of the union and it was only by mere accident that he did not meet the same fate. The fight which he waged against the union at this time was so strong that his life was threatened on a number of occasions.

In 1901 he again opened an office in New York, and since then has devoted his time to consulting engineering work with headquarters at 60 Wall Street. In addition to other duties he is now consulting engineer of the British Columbia Copper Co., president of the Cuba Copper Co., and consulting engineer and general manager of the Kerr Lake Mining Co., Cobalt.

In January, 1890, Mr. Lawrence married Miss Alice Jerome, daughter of Addison G. Jerome, of New York, and has one child, a daughter. He is a member of the American Institute of Mining Engineers and the University, the Union, Downtown, Columbia University, Garden City Golf and American Yacht clubs.

It is eminently proper that the first alumni trustee should have been selected from among the men who, as graduates of the School of Mines, have gone out into all parts of the world to make names for themselves and fame for their alma mater. It is a cause for great satisfaction that the man selected from this body is one who has made his mark by hard work and constant pursuit of his profession for a period of more than thirty years, and who during this time has maintained the greatest interest in the welfare of Columbia University. The addition of such a man to the board of trustees cannot but add to the cordial relations that already exist between them and the vast army of alumni, and tend still further to expand the great work that is already being done.

A. L. WALKER.

NOTES ON DIAMOND DRILLING AT THE MICHIGAN COPPER MINE, ROCKLAND, MICH.

By CLARENCE M. HAIGHT, E.M.

The outfit consists of a Sullivan drill of the "H" type, with the necessary tools; a portable boiler of 20 H.P., mounted on wheels, together with the necessary piping and tools; a small engine, or "puffer," for pipe driving, and pumps for water pressure and washing. To shelter the machinery and men there is a shanty, built in sections to facilitate moving from place to place. This has two rooms, one of which contains the boiler, drill, pumps and puffer; with a smaller one for the foreman, in which he sets the bits and makes out his reports. The cores are also kept in the small room, until taken to the engineer's office. The tripod is made of spruce poles, cut on the property, and is capable of handling 30 feet or three lengths of rods at a pull.

In prospecting work the sludge is saved as well as the core. To this end, a two inch pipe is used at the collar of the hole, the bottom end of this pipe being cemented to the ledge. This is done whether the hole is started directly in the ledge or whether a pipe has to be driven to the ledge through the overburden. The top of the pipe reaches to the floor of the shanty; to it is attached a tee, from which a pipe leads into the setting room. The bit is set for a 1⅞-inch hole, and a 1⅛-inch core is obtained, which is collected in a core barrel ten feet long. The sludge, as it is washed up, passes through the tee and pipe into the setting room, where it flows into a V-shaped trough, four feet long. This in turn empties into a shallow box, two inches deep, one foot wide and five feet long, which is crossed by riffles one inch high, made removable for cleaning. By this means all but the lightest particles of the sludge are caught.

The search being for native copper, the foreman collects some of the sludge from the trough at intervals of about six inches advance and pans it, noting the presence or absence of copper. Should anything of promise appear, the riffle box is at once cleaned out in order that the copper sludge may be caught separately for assay.

In the night shift the drill runner attends to this work. The crew consists of the foreman, who sets the bits, a drill runner and a fireman; at night there is no foreman.

At the drill the cores are filed in small boxes, each holding 25 linear feet. When full, these boxes are taken to the mine office, and there undergo a careful examination by the mining engineer, who makes any notes that may be required, in addition to those on the report sheets. The engineering department keeps the records of the work, compiling them from the daily reports and the core examinations.

Samples of the daily reports, covering a period of twenty-four hours, are shown herewith.

MICHIGAN COPPER MINING COMPANY.

DRILL RUNNER'S DAILY REPORT. *Hole No.* 23

Date Nov. 27 1908 *Shift* Day

	Started Drilling.	Started Pulling.	No. of Feet Drilled.	REMARKS: Causes of Delays, Etc.
1	7.00	9.30	3′-6″	
2	10.15	11.50	2′-8″	
3	12.20	2.15	4′-7″	
4	2.45	5.30	8′-7″	Lowering rods when night shift came on.
5				
	Total Drilling - -		19′-4″	J. Gubba, Runner.

MICHIGAN COPPER MINING COMPANY.

DRILL RUNNER'S DAILY REPORT. *Hole No.* 23

Date Nov. 27 1908 *Shift* Night

	Started Drilling.	Started Pulling.	No. of Feet Drilled.	REMARKS: Causes of Delay, Etc.
1	6.10	8.10	4′-10″	
2	8.35	10.00	2′-10″	
3	10 45	3.00	8′- 6″	
4	4.00		5′- 0″	
5				
	Total Drilling - -		21′- 2″	Johnson Runner.

By the preceding report it is seen that, after ten minutes, the night shift had finished lowering; also, that when day shift came on, the night shift were still drilling, which was continued by the day shift.

MICHIGAN COPPER MINING COMPANY.

DAILY DRILL REPORT. *Hole No.* 23

Date Nov. 27 1908 *Runner* Joe Gubba *Shift* Day

From	To	Total	Time Drilling	Time on Rods	Bit No.	Length of Core	Kind of Rocks	Remarks
179.11	183.5	3.6	2.30	0.45	6	*7'-10"	Trap—dark, chloritic	Some fine copper
183.5	186.1	2.8	1.35	0.30	6	2'-1"	6" Trap—rest vein	Vein at 184'
186.1	190.8	4.7	2	0.30	5	3'-7"	All vein	No copper
190.8	199.3	8.7	2.45	0.25	5	0'-6"	Vein and soft red trap	
		19'.4"	8.50	2.10		14'-0"		

Remarks Pulled often to save core

Vein from 184 to 194 feet. *Setter* T. H. Johns.

MICHIGAN COPPER MINING COMPANY.

DAILY DRILL REPORT. *Hole No.* 23

Date Nov. 27 1908. *Runner* Johnson *Shift* Night

From	To	Total	Time Drilling	Time on Rods	Bit No.	Length of Core	Kind of Rock	Remarks
199.3	204.1	4.10	2	0.45	6	0'-4"	Trap—soft, brownish	
204.1	206.11	2.10	1.15	0.45	6	0'-4"	Trap—soft, brownish	
206.11	215.5	8.6	4.15	1	6	2'-0"	Epidote	Vein matter from 207'-216'
215.5	220.5	5	3	Not pulled by this shift			Trap—red—some chlorite	
		21'-2"	10.30	2.30		2'-8"		

Remarks, core from last run goes with day shift

pulled often to save core

Vein from 207 to 216 feet. *Setter,* T.H. Johns.

The drill runner's report is for the purpose of obtaining data as to the use of the time. The other is a daily summary of a shift's work; it is made out by the foreman and checked by the

* Part of core from last run of night shift.

engineer. Visits to the drill are made at least once a day, by either the superintendent or mining engineer, or both, for the purpose of examining the last cores and noting the progress of the work.

Surveys are made by the hydrofluoric acid method. There is so much magnetite present in the formation that a magnetic needle would be useless. A common bottle of small size, such as druggists use (10 cubic centimeters capacity) is used to hold the acid. This bottle is placed in a special steel receptacle, which screws on to the drill rods (Fig. 1). It is important to make the joint water tight, which is done by a lead gasket. The holes in the top piece, shown in the cross-section, admit the water when lowering and allow it to escape when pulling.

Should it be necessary to pass a stream of water through the rods while they are in the hole, a smaller receptacle (Fig. 2) is used for the acid bottle. This fits inside the core barrel and is kept in place by a blank bit screwed on the bottom of the core barrel. Grooves on the outside allow the water to pass the bottle holder and go through the bit.

A 35 per cent. solution of the acid is used. The bottle is filled two thirds full, and is allowed to stand in the hole for thirty minutes, plus the length of time needed to lower it; that is, if it takes fifteen minutes to lower, the rods are left in the hole for forty-five minutes. This gives a clearly etched marking on the glass, which is easily measured by a goniometer of the Penfield type.

The surveys showed that the two vertical holes referred to in these notes remained vertical throughout. The inclined hole, however, which was started at 50° to the horizontal, showed the following deflections at the different points surveyed:

Depth.	Dip.
Collar	50°
175′	58°
300′	61°
535′	61°
660′	61°
800′	64°
1080′	64°

For the hole now in progress, started an angle of 45°, a drive pipe was put down to the ledge. The first section of pipe was 5 inches in diameter. This was followed successively by a 4-inch pipe to 56 feet, a 3-inch to 100 feet, and finally a 2-inch pipe to 135 feet,

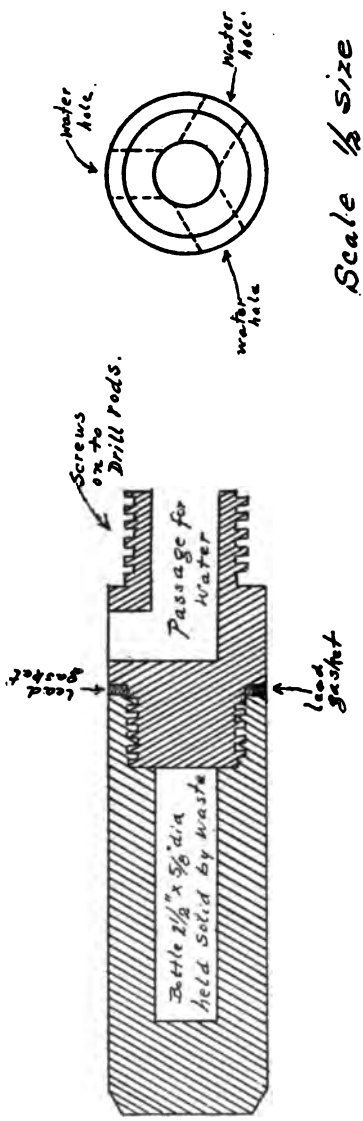

FIG. 1.

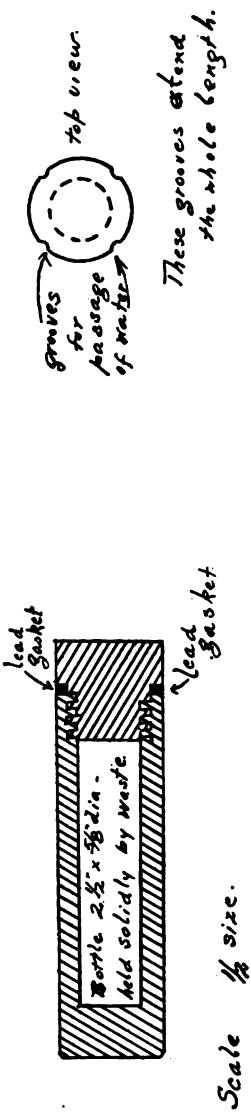
top view
These grooves extend the whole length.
grooves for passage of water
lead Gasket
lead Gasket
Bottle 2½" x 5/8" dia. held solidly by waste
Scale ½ size.

FIG. 2.

at which depth the ledge was reached. The ground was filled with boulders so that the driving was exceedingly difficult, and the 4-inch and 3-inch pipes broke at joints at the depths mentioned above. After the ledge had been reached, trouble was also encountered by the breakage of the couplings of the drill rods. In previous holes, the small inner pipe has always been cemented in place in the ledge, to make a tight joint. For the present hole, however, the 2-inch pipe

was simply tamped with clay at the bottom, to prevent leakage of water. To accomplish this the lower end was set in a recess drilled in the ledge matter by a 2½-inch bit. Thus far this plan has worked well, and has the advantage that the pipe may readily be withdrawn when the hole is finished.

A survey of this hole was made with the following results:—

Depth.	Dip.
Collar.	45°
73′	54.5°
76′	56°
79′	54.5°
82′	50°
85′	50°
100′	42°
106′	41°
132′	32.5°
135′	31.5°

On account of the serious deflection, this hole was abandoned, and a new one started at a dip of 70°. This went down straight and has just reached the ledge (March 28, 1909).

The following sheet gives a condensed summary and analysis, including costs, of several holes that have been drilled at this mine. Holes numbers 21, 22 and 23 were started in the ledge, so that no pipe had to be driven.

COMPARISON OF SUMMARIES.

No. of Hole.	Depth.	Advance.				Carbon.		Percentages.				Total Cost per Foot.
		Per Shift.	Per Hr. of Work.	Per Hr. of Drilling.	Per Bit.	Loss per Foot.	Cost per Foot.	Time Drilling.	Time on Rods.	Delays.	Core Obtain'd.	
—	Feet	Feet	Feet	Feet	Feet	Karats	Dollars	—	—	—	—	Dollars
21	544	13.00	1.31	2.30	24.7	.00656	0.530	58.7	29.7	11.6	80.5	1.65
22	1,191	13.50	1.36	2.23	25.0	.00750	0.600	60.6	22.7	16.7	34.0	1.71
23	802	12.15	1.12	2.00	28.7	.00821	0.656	56.2	21.4	22.4	38.0	1.70

Holes 21 and 23 are vertical. Hole 22 inclined at 58° dip (average).

Analysis of Delays.	Hole 21.	Hole 22.	Hole 23
Repairing drill and connections	33.4 %	27.3 %	22.15 %
Cementing hole	5.1	2.4	3.60
Boring cement	16.4	4.1	22.15
Drilling caved ground	32.3	7.5	26.35
Frozen water pipe	—	24.6	—
Broken rods	—	5.5	—
Recovering jammed bits	—	—	16.55
Setting bits	6.4*	15.0*	2.00
Surveying hole	6.4	13.6	7.20

*Holes 21 and 22 had only one set of diamonds.

FOUNDATION WORK FOR C. AND N.W. RAILROAD BRIDGE ACROSS THE MISSISSIPPI RIVER AT CLINTON, IOWA.*

By M. DEUTSCH, C.E.

This new bridge is on the main line of the C. & N.W. Railway between Chicago and Omaha, and is used also by the Chicago, Rock Island & Pacific Railway for freight transfer, and by the C. B. & Q. Railway for its lines from Clinton, Iowa, to Mendota, Ill. The first bridge at this point was started in 1858 by the Chicago, Iowa & Nebraska Railway, and was completed as far as Little Rock Island in 1859, from which point a car ferry was operated across the west channel to the Iowa shore until 1864, when the west channel was bridged. This early bridge, entirely of wood, was the second one built across the Mississippi River. Since 1864 it has been frequently strengthened and renewed until to-day it has been entirely superseded by a fine, new modern structure designed to accommodate the heavy traffic of the day with provisions for probable increase.

The history of the construction of the Clinton Bridge crossing affords a very interesting insight into the vast strides taken in this country in railroad construction, the true barometer of our industrial development. In 1858 the California gold fever having subsided, the struggle for building and improving the trans-continental railroad, to bring the East and West closer together, was at its height. The heaviest engine belonging to the Chicago & Galena Railway which crossed the first Clinton Bridge weighed (with tender) only 28 tons. The heaviest engine operated over the present bridge weighs (with tender) nearly 5½ times as much — *viz.*, 150 tons. It is interesting to note also that the railroad mileage in actual operation has increased from 28,789 in 1859, to 229,230 in 1908. The constantly increasing traffic across this old bridge, amounting to-day to 150 or more trains in 24 hours, necessitated a reduction in train speed, so that in 1900 the Chicago &

* Lecture delivered before the graduating class in civil engineering at Columbia on April 27, 1909.

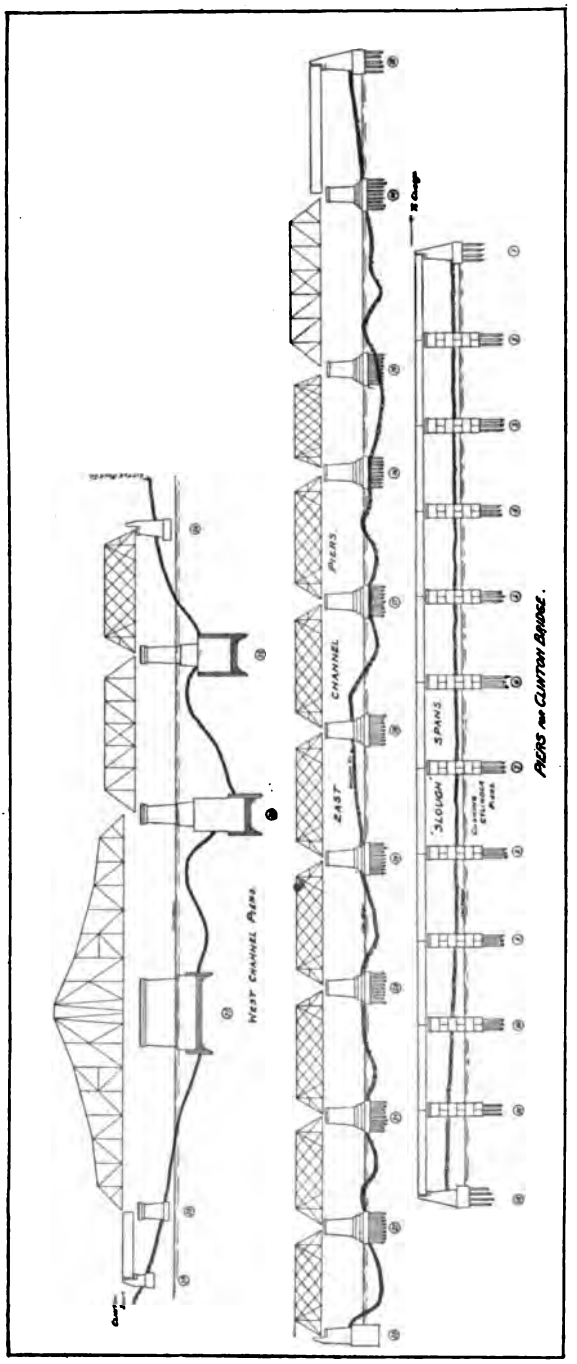

FIG. 1. General elevation, showing all piers.

N.W. Railway Co. determined upon replacing it by an entirely new structure.

The first bridge was designed for a moving load of 2,500 lbs. per lineal foot, while the new bridge was designed for Cooper's E-50 loading (the engines for which weigh, with tender, 177½ tons), which includes a uniform moving load of 5,000 lbs. per lineal foot. A marked improvement is also to be noted in the construction of bridge foundations. It was not until 1869 that the first pneumatic pier foundations west of the Allegheny Mountains were put down, and these were for a bridge across the Missouri River at Omaha. Up to 1859 only two bridges had been built in the United States on pneumatic pile foundations. One across the Pedee River, and the other across the Santee River in South Carolina. All of the east channel piers of the original bridge at Clinton were of cut stone masonry on a foundation of piling capped with a wooden grillage. The center pier and the two rest piers of the draw span in the west channel were founded on wooden cribs loaded with stone and sunk to the river bed, a method which to-day would no longer be thought of for a permanent structure. The remaining west channel pier was built on piling capped with a wooden grillage.

This crossing between Clinton, Iowa, and Fulton, Ill., is about 4,200 feet and is probably one of the longest continuous truss-span bridges in the world. This long stretch is only broken by two small islands — Little Rock Island, which is above high water, and Willow Island, below high water. The foundation work for this bridge is especially interesting in that nearly every known method of building bridge foundations was employed in founding the various piers. For the "slough" spans (see Fig. 1) the total length of which between back walls of abutments is 550 feet, there were built 10 pairs of Cushing cylinder piers (no. 2 to no. 11 inclusive) with 15 to 18 piles in each cylinder. The two abutments (no. 1 and no. 12) are of dimension stone (Red Rock sandstone from Ableman's, Wis.) resting on timber piles capped with concrete. The cylinder piers rest upon sand of unknown depth overlying which is a few feet of muck. Below a water stage of about minus 10 there is little or no flow in the slough, and the piers are protected from either ice or drift by a fixed timber boom. The pile trestle on the old bridge at this point had remained in good condition for 50 years.

FIG. 14. The traffic was maintained over the old bridge during the construction of the new one.

The Cushing cylinders were built up of six riveted steel plate sections 3/8 in. thick and 5 ft. high. In each cylinder there are from 15 to 18 piles, averaging about 28 feet long and cut off 2 feet below low-water level. The bottom of the cylinder varies from 18–

FIG. 2. Dredging Cushing cylinders.

20 ft. below high water, or about 12–15 ft. below ground level. The cylinders were filled with concrete well rammed and capped with an 18-in. coping of white sandstone, the joint between the top of each cylinder and coping being well caulked with oakum.

FIG. 3. Cushing cylinder piers completed.

The total load on each cylinder amounts to 640,300 lbs. or an average of about 16½ tons per pile, or 6 tons per sq. ft. of the area of the pier. The piles in the cylinders were driven from leads suspended from a derrick car, which was run along a temporary

pile trestle built along the center line of the bridge. A series of jets were moved about the lower ends of the cylinders, and together with a load of pig iron enabled them to be forced down to 12 to 15 ft. below ground level. These 20 Cushing piles were completed in six months.

The quantities in this section of the work amounted to,

Timber piles.	602
Cut stone	1,109 cu. yds.
Concrete	1,334 " "
Steel in cylinders.	147.3 tons

East Channel Piers.

All of these piers (14 to 22 inclusive) and abutments no. 13 are built on piling. Abutment no. 23 was carried to rock in an open pit. They were all located practically opposite those in the old

Fig. 4. East channel piers, steel sheet piling.

bridge, and as the center line of the new bridge is about 40 feet from that of the old one, considerable difficulty was encountered in building them owing to the rip-rap piled about the old piers. This brought the ground level on the upstream end of the new piers above low water while at the downstream end over 22 feet below low water.

Piers nos. 15, 17, 20, 21 and 22 were built with a concrete footing laid upon a wooden grillage resting directly on the pile. At these piers owing to the slope of the rip-rap and to the depth of

water (in cases over 20 feet) the piles were completely surrounded with rip-rap to obtain a level bottom upon which the timber crib was then lowered. At piers 13, 14, 16, 18 and 19 the ground surface was only a few feet below water level, and in some cases could be brought above water level by a very small fill. At piers nos. 13 and 18 single lines of Wakefield sheeting were driven forming a cofferdam, inside of which the masonry was deposited directly on the piles. Single rows of sheeting were used at those piers where the ground level was above water level, or could be brought above it by a small fill. Where the water was deep — over 10 feet in depth — a cofferdam of double rows of U. S. steel sheetpiling was built around the piles and filled with puddling material. This was done on all the remaining piers except nos. 19 and 23, where single rows of U. S. steel piling were used.

The vibration caused by the driving of the steel piling at pier no. 16 settled the adjoining pier of the old bridge to such an extent that much time was lost owing to the necessity of taking special precaution in the further prosecution of this work. As a result the piles were cut off at about 11 feet below water, and by using a tremie pipe part of the concrete of the footing was deposited before pumping out the cofferdam. In this way an inflow of material from the adjoining pier was avoided.

At pier no. 17 we started driving steel sheeting. It was almost impossible to continue this owing to the piling having encountered an old highway span at the bottom of the river. This iron span which was to have been used in the adjoining highway bridge was blown over in a heavy wind storm several years ago, falling directly on the site of the new pier (no. 17).

The attempt to remove this half-buried ironwork would have been expensive and time consuming, so that it was finally decided to drive timber piles, cutting them off under water with a rotary saw. An open caisson was then lowered over these piles.

The quantities in this section of the work are as follows:

Piles	1,782
Grillage	128,064 ft. B.M.
Cofferdam, timber and bracing	3,041,700
Concrete	2,186 cu. yds.
Cut stone masonry	4,293 " "
Rip-rap	1,500 " "

To facilitate the handling of the materials of construction a temporary pile or trestle (see Fig. 4) was built between the main

piers of the new bridge and along its center line. This trestle was built of 16 ft. spans consisting of 5 piles to the bent and caps 28 ft. long. At some of the piers a stiff leg derrick was set up on piling, but as far as possible the material was handled with a Browning hoist crane or a derrick car (see Fig. 2).

FIG. 5. East channel spans looking west.

This section of the work was completed in about nine months — started July 3, 1907, and finished March 14, 1908.

WEST CHANNEL PIERS.

The main part of the stream between Little Rock Island and the Iowa shore (known as the west channel) is used exclusively by steamers. It is the deeper of the two channels and at low water is only 600 feet wide, and at high water 850 feet wide. During high water timber and log rafts are passed through the east channel span 14–15. During the winter of 1907–08 it became necessary to dynamite in the main channel in order to break up the ice jam.

Owing to the greater possibility of scour around the piers caused by the construction by the U. S. engineers of dams of rip-rap and brush between the heads of Little Rock and Willow Islands, since the old bridge was built, it was decided to carry all of the piers in this channel down to rock. The borings taken at pier no. 26, April and May, 1908, gave the correct elevation of bed rock. The original borings taken by the railway company in 1901 were found to have been incorrect, the actual bed rock being some 25 to 30 feet deeper than the original boring had shown. The pneumatic caisson for pier no. 26 had already been designed and built for the depth of sinking to about 55 feet. To have attempted to sink this timber caisson to the greater depth of 90 feet without adequately reinforcing them, would have been a procedure fraught

with danger. After a study of the plans and of the results of the new boring taken May, 1908, the railroad company permitted the contractors to carry the caisson to 62 feet and then called upon them to sink four wells 6 ft. in diameter 18 ft. further through the sand, clay and gravel.

Piers nos. 24, 28 and 29 were built in open cofferdams made with single rows of U. S. steel piling and are founded upon a soft, porous, buff limestone belonging to the Niagara series of rocks. Piers nos. 25 and 27 are founded in a hard, compact, white limestone, while pier no. 26 rests upon a peculiar pre-glacial deposit of sand and clay. These lie below the limestone slabs at Elevation 55, which in the original borings was mistaken for bed rock.

These three latter piers were sunk by means of pneumatic caissons. The deepest of these piers was no. 26, which was carried to about 80 feet below low water. The greatest air pressure was about 39 lbs., and this occurred only while the 6-ft. cylinders were being put down in the botton of caisson no. 26.

Then the men worked in shifts of only three to four hours. When the pressure did not exceed 20 to 25 lbs., which was generally the case, the men worked in three shifts of eight hours each. Great precaution was taken by the pressure foreman to prevent the workmen from leaving the lock too rapidly. This was accomplished by placing a regulating valve of a diameter of about 1½ ins. which regulated the time of escape of the air from the lock chamber, and hence prevented the men from leaving it too soon. Under a pressure of about 35 lbs. the time required for the equalization of the pressure in the lock chamber with that of the atmosphere amounted to fifteen to twenty minutes.

Pier no. 25 was sunk to bed rock found at an elevation of about 56 ft. below low water. This was accomplished between the months of January to April, 1908. The caisson used in this pier is 24 ft. wide, 64 ft. long and 14 ft. 8 in. high. The walls of the working chamber which provides a head room of 6 ft. to work in, are built up of 2 rows of yellow pine timber, one horizontal 12 × 16 ins. to which the outside 3 in. vertical planking is nailed, and the other 12 × 12 ins. The roof of the working chamber is built up of two parallel layers of 12 × 16 in. timbers, with an intermediate 12 × 12 in. layer laid in a direction at right angles to the other two.

After launching the caisson a crib was built by continuing the timbers of the caisson to a height of 14 ft. above the latter. Above

this was then built a cofferdam 23 ft. 6 ins. above the top of the crib or to about 10 ft. above low water. Fig. 6 shows a typical design for a "pneumatic caisson" pier.

The east pier, no. 26, of the draw span is the deepest pier and

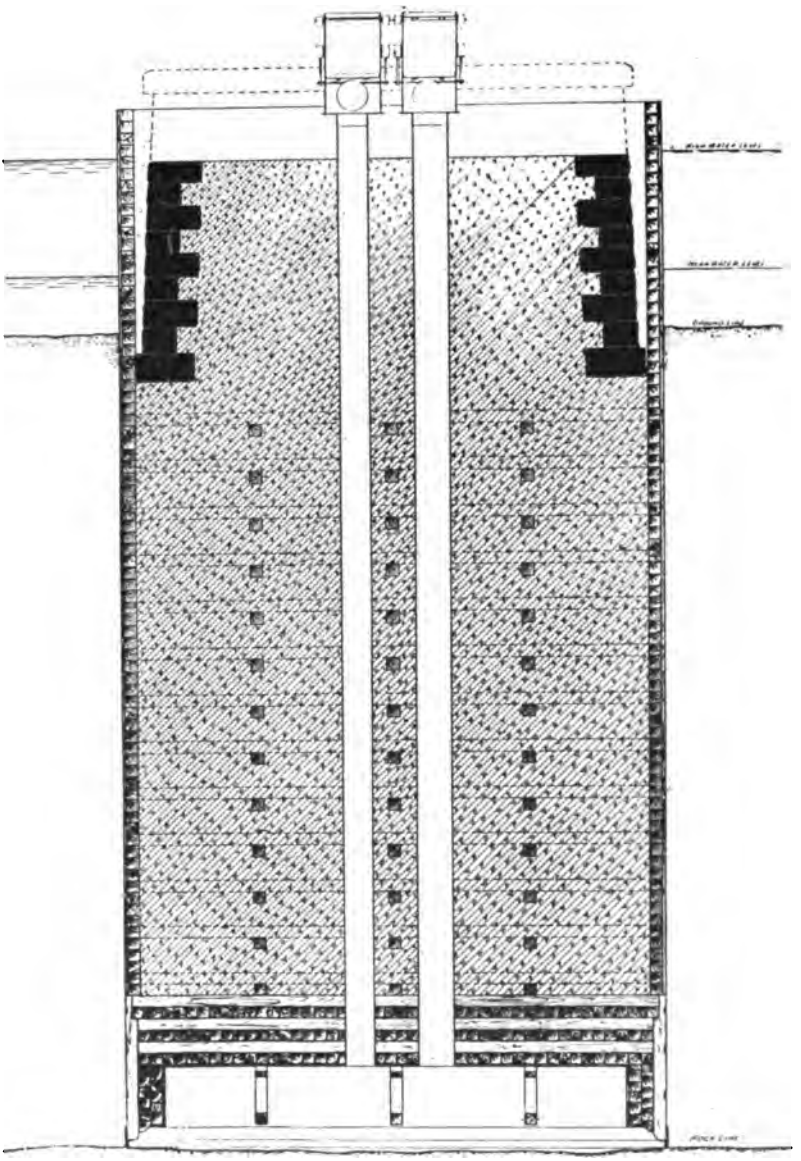

FIG. 6. Shows a typical design for a "pneumatic caisson" bridge pier.

is most exposed to the current during low water. It took about three and one half months to complete. Soundings taken on the site for this pier showed a depth of water of 21 ft. on one side and 46 ft. on the other side. The material on the high side is rip-rap put in there to protect the adjoining old pier on the west side of the caisson. On the west side of the caisson the high water had scoured out the material so as to leave a slope of about 45° on which to lower the caisson. This would plainly have been an impossible thing to execute properly without first leveling off the bottom. A jet was rigged up to wash some of this away. This was followed by using clamshell and orange peel dredges.

Previous to the sinking of piers nos. 25 and 26 it was thought best to safeguard the adjoining old piers from a large settlement, to drive steelsheet piling around these piers. Accordingly interlocking piles of the U. S. patent were driven in an elleptical form around the old pier and no. 25 to a depth of about 25 ft. below the piling and about 20 ft. below the crib of old pier no. 26. The levels at the end of the work showed only a slight settlement of about 2 in. at the south end of no. 25 and ½ in. at the south end of no. 26.

The caisson of pier no. 26 was built in a similar manner to that of pier no. 25. It is 24 ft. wide, 64 ft. long and 14 ft. 8 in. high, with a working chamber 6 ft. high. The crib above the caisson is 5 ft. high and the cofferdam 41 ft. 9 in., and reaches to about 10 ft. above low water.

Pier no. 27 for the 460 ft. Draw Span.

The caisson for this pier was built octagonal in form with a length of side of 19 ft. 2¼ inches, and a total width of 46 ft. 6 in. The height of the caisson proper is 11 ft. 4 in.; that of the crib 5 feet and the cofferdam was 25 ft. above the top of the crib and about 10 ft. above low water. After the masonry was in place about 14 feet of the cofferdam was removed. The deck of the caisson was built of four yellow pine courses of 12 × 12 ins., each course being placed at an angle of 45° with the next one above.

As the protection pier of the old draw pier lapped over into the site for the new pier no. 27, it was necessary to sink the latter through the crib belonging to the protection pier. This was a very unique and difficult piece of work and was carried out as follows: The west side of the new pier was supported on some

5,000 bags of sand placed outside and under the cutting edge. This was better than dumping the material along the outside of the pier, as the scour was very great at this point, and there was furthermore a considerable slope to the bed of the river. As the sinking continued the side of the crib was adzed out under compressed air and simultaneously the sand from under the west side of the caisson was removed one bag at a time.

The material in the pneumatic caisson that was fine enough was removed by the use of two blow pipes, one at each end of the caisson, upstream and downstream.

An improved Moran air lock (the invention of Mr. D. E. Moran ('84 C.E.) and vice-president of The Foundation Co.) was placed in the center of the caisson through which the larger masses of rock, timber, etc., were hoisted out in buckets. After the caisson had reached its final level the concrete was lowered through the air lock and the water seal made under air pressure. Owing to the ingenious device of providing separate man and material compartment in the shaft leading down to the working chamber, the men can go up and down without any danger of being struck by a passing bucket, so that the danger to the men from this source has been entirely eliminated by the contractors. A collapsible shaft patented by the company enables their easy removal for use over and over again.

As the current was very strong in the Mississippi River at this point, special precautions had to be taken during the launching and sinking of the caissons. One interesting device was the use of a Chinese anchor. It was figured that there was about 50 tons pressure against the caisson from the current, so that it would take a good fastening to hold it in place, this assuming a 5½ mile current and the caisson submerged 50 feet (see Fig. 7).

Quantities for West Channel Pier.

The total amount of timber used in cribs and caissons, 509,561 ft. B.M. Cofferdam timbers and bracing, 654,630 ft. Concrete, 5,900 cubic yards. Dimension stone, 3,322 cubic yards. Masonry.

To accomplish the construction of these 23 piers and six abutments a very large plant equipment was required which included the following:

Boilers; Drills — McKiernan no. 2½, Ingersoll no. 2; Dredges — Clam Shell Dredge, 1 cubic yard bucket with steel teeth on each shell, Hayward Orange Peel; Dynamo — 7½ k.w.; Engines

— Ames horizontal 8 × 8, Lambert hoisting engine 8¼ × 10, Lambert hoisting engine 7 × 10, 6 Lidgerwood hoisting engines, Mundy hoisting engine 8 × 12 in. double cylinder; Pile hammer — Pneumatic riveter; 3 Worthington steam pile hammers no. 1, Browning no. 1 locomotive, double drum; Locomotive standard

FIG. 7. Shows the building of the Chinese anchor in mid-stream.

gauge, saddle tank — size 11 × 16, water capacity 500 gallons, coal 500 lbs., Davenport Locomotive Co.; Concrete Mixers — Chicago cube, no. 22, Oleson mixer, Smith no. 2½.

Pumps — Centrifugal 10 ins. direct connected to vertical engine, 10 × 10 ins., centrifugal 8 in. suction D.C. 8 × 6 ins., centrifugal Kingsford 6 in. D.D., centrifugal Lawrence 5 in. special coupled to 4 × 4 in. engine, centrifugal Lawrence 10 in. suction 8 in. discharge D.D. to engine 8 × 8 in., centrifugal Lawrence 12 in.,

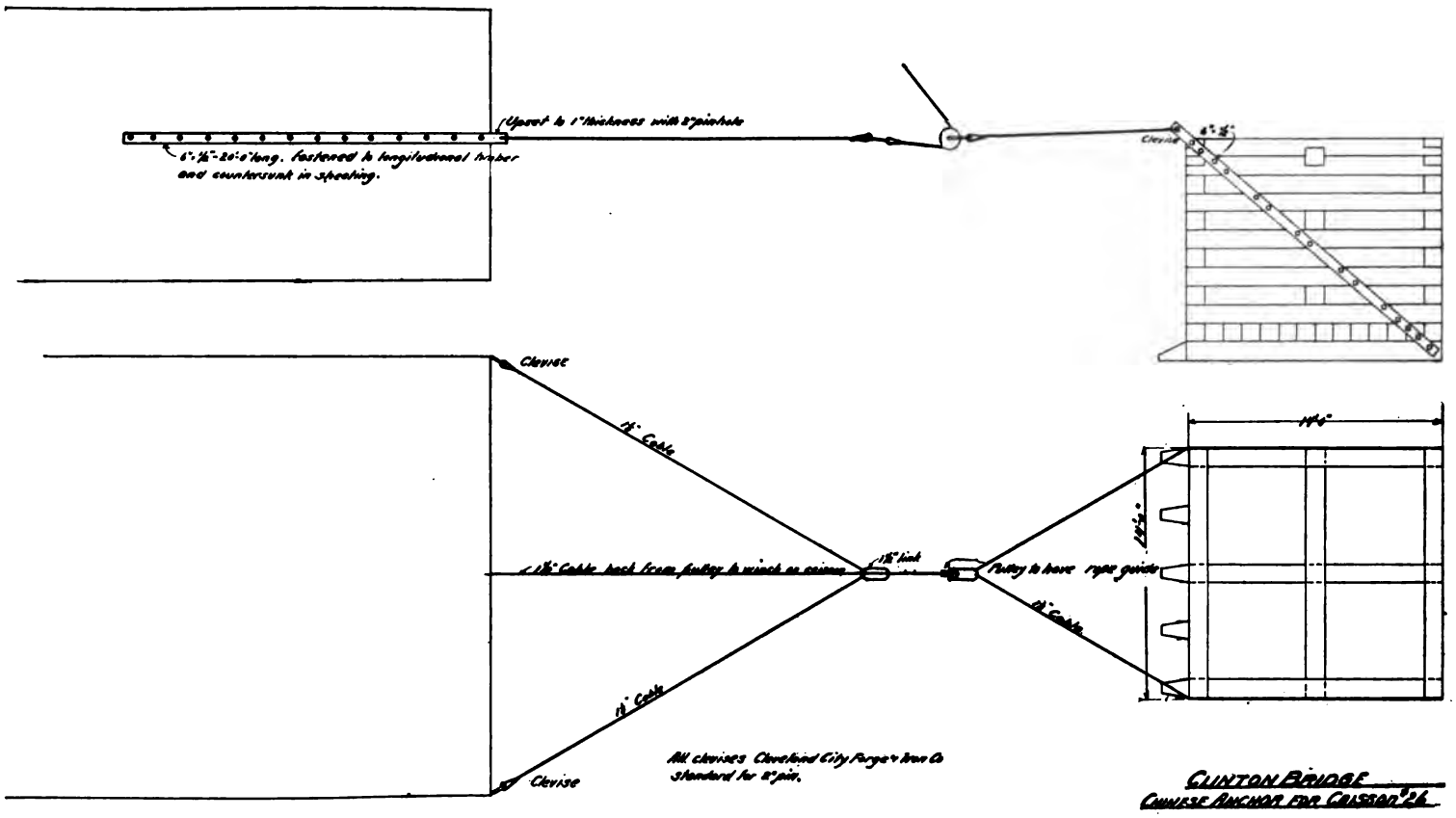
Upset to 1" thickness with 2" pin hole
6"-1½"-20'-0" long. fastened to longitudinal timber and countersunk in sheeting.
Clevise
Clevise
1¼" Cable
1¼" Cable back from pulley to winch as shown
1¼" link
Pulley to have rope guide
1¼" Cable
1¼" Cable
Clevise
All clevises Cleveland City Forge & Iron Co Standard for 2" pin.
CLINTON BRIDGE
CLEVISE ANCHOR FOR CAISSON "A"

FIG. 8. Shows the method of construction.

1 Emerson pump, 4 Fairbanks-Morse duplex, 1 boiler feed pump, 1 Duplex Worthington 12 × 4½ × 10 ins., 1 Duplex Worthington 12 × 18½ × 8½ × 10 ins., 1 Duplex Worthington 12 × 18½ × 8½ ins.; pneumatic wood-boring machines; 3 flat cars 34 ft. long, capacity 50,000 lbs.; switchboard; air-receivers, etc.

Test Borings.

Test borings were taken from a scow 15 ft. wide, 32 ft. long on the bottom and 37 ft. long on top. A tripod consisting of three pieces of Douglas fir 5 × 8 in. and 32 ft. long was mounted on the scow and an 8 in. wrought-iron pipe near its center and bolted with a pipe flange to the bottom of the scow was used for a well through which the bore pipe was passed. A Sullivan Diamond Drill with 2 in. core bits was used. For the boring a 4½ in. standpipe and 2½ in. casing pipe with flush joints were passed through the well in the center of the scow.

The borings in the west channel showed the following:

Below river bed there is about 6 ft. of alluvial sand (to el. + 0.0), and below this for about 55 ft. glacial drift (gravel, sand and boulders) (to el. — 55); for the next 7 ft. (to el. — 62) there were found slabs of native limestone rock separated by a deposit of sand with a matrix of carbonaceous or ferruginous clay interspersed with foreign glacial drift. For the next 27 ft. (to el. — 89) there was found a deposit of sand with a matrix of ferruginous or carbonaceous clay. Below the elevation of about 93 below water level, or about 73 ft. below the bed of the river, cores were obtained of a limestone rock belonging to the Delaware stage of the Niagara series. On account of the motion of the scow it was not thought advisable to use a diamond drill, but using the saw tooth bit it was hard to penetrate to any depth this hard and flinty limestone.

Some of the borings were carried down from 30 to 40 feet into the limestone bed rock to investigate the probable presence of subterranean pockets. Only two of these were found and these in the same bore hole were only 12 and 6 in. in depth.

It was decided to stop caisson no. 26 at about elev. — 62, owing to the irregularity of the formation between el. — 55.0 and — 62 uneven settlement might cause crack in the masonry.

The extreme limit of possible scour was taken at — 55 and a safe loading for the ferruginous clay was considered at four tons square foot, and for the carbonaceous clay five tons square foot.

[Contribution from the Havemeyer Laboratories, Columbia University, No. 170.]

A NEW RAPID VOLUMETRIC METHOD FOR THE DETERMINATION OF NIOBIUM IN THE PRESENCE OF TANTALUM AND ITS APPLICATION TO THE ANALYSIS OF NIOBIUM MINERALS.

By F. J. METZGER and C. E. TAYLOR.

The determination of niobium and tantalum, when existing together, has always been a stumbling block to the analytical chemist. The only method at present available is one based on the fractional crystallization of the double fluorides of these elements with potassium. The results by this method at best can be only approximate, as may be understood when the relative solubilities of these two double salts are considered. The solubility of the double potassium tantalum fluoride being given as one part of salt in 200 parts of water, whereas the corresponding niobium salt is soluble one part in 12.5 parts of water. Although with considerable experience and care duplicate analyses may be made by the crystallization method which show agreement, within about one per cent. or even less, the values obtained do not represent the actual amounts of the elements present, as is reasonable to be supposed from the solubilities given above.

Osborne * describes a method for the determination of niobium and tantalum in the presence of titanium, which involves the reduction of the hydrochloric acid solution (containing a small amount of fluorides) of the combined elements, titration of the niobium and titanium, determination of the titanium colorimetrically, the tantalum being found by difference. But one determination is reported, which was made on a known mixture of oxides.

Warren † found the method of Osborne to be very inaccurate.

After a great deal of preliminary experimentation, it was found that, if succinic acid was added to a solution of niobium and tantalum in strong sulphuric acid, the solution could then be largely diluted, also heated, without precipitation of either the niobium or tantalum. This fact formed the basis of the work which follows.

* *Am. Jour. Sci.* (1885), 30, 328.

† *C. N.* (1906), p. 298.

Experimental.

Inasmuch as succinic acid is not affected by potassium permanganate in acid solution, it was thought that the niobium might be reduced by zinc and acid and then titration made with potassium permanganate, and that the tantalum should remain unaffected by either operation.

Material. — The material used in this work was prepared from South Dakota columbite, the niobium and tantalum freed from impurities by the usual method, then subjected to many recrystallizations, finally obtaining niobium and tantalum double fluorides of a high degree of purity.

Preliminary experiments showed that the niobium could readily be reduced when in sulphuric acid solution containing succinic acid, and could then be titrated by means of potassium permanganate solution, and that the presence of tantalum did not interfere.

Standardization of Solution. — The first experiments were made to determine the potassium permanganate standard in terms of Nb_2O_5. The experiments were made as follows:

About 0.2 gram of Nb_2O_5 was fused with potassium bisulphate, the fusion treated with 40 c.c. of concentrated sulphuric acid by adding part of the acid to the crucible, heating to a clear solution, transferring the solution to a beaker and cleaning the crucible by washing with the remainder of the acid. Six grams of succinic acid were then added to this concentrated sulphuric acid solution, which was then diluted somewhat with a saturated aqueous solution of succinic acid, and water added to a volume of 200 c.c., and while still quite warm (from dilution) passed through the reductor, followed by 200 c.c. of about 5 per cent. sulphuric acid, and titrated immediately with potassium permanganate solution.

Results are given in terms of Nb_2O_5 per c.c. of potassium permanganate solution used, and also, in the last column, the values converted to terms of exactly N/10 $KMnO_4$.

No.	Nb_2O_5 Taken.	Time, Minutes.	$KMnO_4$ Required c.c.	Nb_2O_5 per c.c. of Solution.	Nb_2O_5 per c.c. N/10.
1	.2224	7½	28.97	.007677	.00781
2	.2016	8½	26.20	.007702	.00783
3	.2338	7½	29.99	.007795	.00792
4	.2174	8½	27.21	.007699	.00782
5	.2174	10	28.22	.007704	.00783

The reductor used was 19 inches in length by ¾ inch in diameter, and was filled with amalgamated zinc.

A blank experiment containing sulphuric acid and succinic acid was made, and the deduction (0.1 c.c.) allowed.

At this point a different potassium permanganate solution was employed as well as a freshly amalgamated lot of zinc.

Zinc Considerably Amalgamated. — Temperature 75° C., 3 grams of sodium bicarbonate in the flask.

Titrations were made as follows:

No.	Nb_2O_5 Taken.	Time, Minutes.	$KMnO_4$ c.c.	Nb_2O_5 per c.c. of Solution.	Nb_2O_5 per c.c. N/10.
6	.2002	8	22.80	.008781	.008558
7	.2009	9	24.65	.008150	.007943
8	.2077	9	25.05	.008291	.008081
9	.2047	8	24.20	.008121	.007915
10	.2046	7	24.40	.008385	.008173
11	.2034	6	24.15	.008422	.008209
12	.2079	10½	24.10	.008626	.008408
13	.2115	8	24.15	.008758	.008536
14	.2086	9	23.75	.008792	.008569
15	.2054	9	23.10	.008688	.008469

In (10) to (12), inclusive, the solution was passed through the reductor at a boiling temperature instead of at 75° C.

These results, although very irregular, are considerably higher than have been obtained previously; that is, the reduction was less complete. It was further noticed that the reductor in the above experiments (6) to (15) was less active than in previous experiments, and it was assumed that the degree of amalgamation of the zinc might be of some significance.

Slightly Amalgamated Zinc. — Less mercury (the amount, however, not being weighed) was used in amalgamating the zinc employed in the following experiments:

No.	Nb_2O_5 Taken.	Time, Minutes.	$KMnO_4$ c.c.	Nb_2O_5 per c.c. of Solution.	Nb_2O_5 per c.c. N/10.
16	.2051	13	28.10	.007300	.007114
17	.1988	14	27.30	.007281	.007096
18	.2046	15	28.55	.007166	.006984
19	.2074	16	28.45	.007290	.007105
20	.2129	16	29.30	.007266	.007082
21	.2018	16	27.25	.007405	.007218
22	.2121	17	28.90	.007337	.007152

These results show greater reduction of the niobium than any previously obtained, due, undoubtedly, to the fact that less mercury was used in the amalgamation of the zinc.

In experiments (19) and (20) an atmosphere of hydrogen was

maintained throughout the reduction and titration. In experiments (20) and (22), as well as all experiments to follow, an atmosphere of carbon dioxide was maintained throughout the reduction and titration, employing a Kipp generator for carbon dioxide and a long-stemmed burette for the titrations.

Unamalgamated Zinc. — In view of the more complete reduction shown in the table above, where slightly amalgamated zinc was used, it was thought that perhaps there might be some advantage in the use of unamalgamated zinc in the reductor. Experiments were, therefore, made, filling the reductor with 20–30-mesh C.P. zinc, unamalgamated, but the action of dilute sulphuric acid was so very vigorous that the solution could not be drawn through the reductor sufficiently rapidly to prevent stoppage due to the matting together of the fine particles of zinc.

Conditions Adopted for Amalgamation. — It was now believed that, by adopting well defined conditions for the amalgamation of the zinc, uniformity of results might be obtained, and that these results would be more constant when the zinc is amalgamated only slightly.

The amalgamation of the zinc used in all experiments which follow was carried out in detail as described below.

Six hundred grams of 20–30-mesh C.P. zinc was amalgamated with a solution made by dissolving 0.5 gram of mercury in 25 c.c. of concentrated nitric acid and diluting to 250 c.c. with water. The zinc was shaken in this solution for several minutes, washed with water, then with dilute sulphuric acid, and kept under water until required for use in the reductor. The deduction for a blank on this zinc was 0.1 c.c. $KMnO_4$ solution.

Pure Oxides. — The supply of pure Nb_2O_5 having become exhausted, a new lot of material was prepared by taking two different samples of niobium salt and separating each of these into three fractions, which are designated in the table following as I_1, I_2, I_3, and II_1, II_2, II_3.

Procedure. — Inasmuch as every determination from this point was made in exactly the same manner, the exact details of the procedure are here given.

The oxide (or mixture of oxides) is fused with 5 grams of potassium bisulphate in a 30 or 40 gram platinum crucible. To the cooled mass 10 c.c. of concentrated sulphuric acid is added and heat carefully applied until a perfectly clear solution is obtained,

which is allowed to cool, and the contents of the crucible transferred to a beaker, the crucible being rinsed with 30 c.c. of concentrated sulphuric acid. The solution should be perfectly clear at this point (any cloudiness shows incomplete fusion). Two grams of succinic acid are then added and the contents of the beaker stirred for a short time, about 20 c.c. of a saturated aqueous solution of succinic acid is then added in a fine stream from a wash bottle with constant agitation, then water is added to a volume of 200 c.c., and the solution heated to a temperature of 75° C. Meanwhile the reductor is prepared by passing through it 200 c.c. of 5 per cent. sulphuric acid heated to 75° C., rejecting this acid and filling again with 20 per cent. sulphuric acid heated to 75° C. The niobium solution is then passed through the reductor, followed by 50 c.c. of 20 per cent. sulphuric acid, and then by 200 c.c. of 5 per cent. sulphuric acid. The reduced solution, which is dark brown in color, is titrated with a standard potassium permanganate solution, the whole operation being carried out in an atmosphere of carbon dioxide. During the titration the solution first changes from brown to green, then through various shades of blue to colorless, the end-point being the characteristic color of the potassium permanganate. The end-point is very sharp. After each determination a few centimeters of the zinc is removed from the top of the reductor and replaced by fresh material, this being necessary, as otherwise a layer of finely divided zinc accumulates which would ultimately clog the reductor.

DIFFERENT SAMPLES OF OXIDE.

No.	Sample.	Nb_2O_5 Taken.	Time, Minutes.	$KMnO_4$ c.c.	Nb_2O_5 per c.c. of Sol.	Nb_2O_5 per c.c. N/10.
23	I_1	.2148	10	28.00	.007671	.007477
24	I_1	.2051	16	26.60	.007711	.007515
25	I_2	.2017	27	26.80	.007526	.007335
26	I_2	.2012	31	27.50	.007316	.007131
27	I_2	.2010	24	26.70	.007528	.007337
28	I_2	.2033	37	26.90	.007557	.007366
29	I_3	.2079	23	27.60	.007532	.007341
30	I_3	.2031	35	27.05	.007508	.007318
31	II_1	.2011	20	27.85	.007221	.007038
32	II_1	.2012	28	27.95	.007199	.007016
33	II_2	.1997	16	27.80	.007183	.007002
34	II_2	.2048	16	28.00	.007314	.007129
35	II_2	.2035	16	27.75	.007333	.007148
36	II_3	.2012	16	27.50	.007316	.007131
37	II_3	.2031	18	27.80	.007306	.007121
28	II_3	.2077	12	28.45	.007301	.007116
39	II_3	.2033	15	27.85	.007300	.007115

These results indicate highest purity for samples II_1 and II_2, while II_3 seems to show the presence of a slight amount of tantalum. All of samples "I" show the presence of a small amount of tantalum.

Purification of Oxides. — The above samples which indicate the presence of impurity were again purified as follows: All of samples "I" were combined, fused with potassium bisulphate, etc., as usual in the fractional crystallization of the double potassium fluorides. The solution of the double potassium fluorides was evaporated nearly to dryness, dissolved in the least amount of boiling water, and allowed to crystallize, yielding a crop of crystals which, upon careful examination, showed the presence of some needles of K_2TaF_7. The mother-liquor from these crystals was decanted through a filter and the crystals rejected. This mother-liquor was evaporated to fumes with sulphuric acid, boiled with water, etc., as usual, obtaining finally the oxide, designated I_A.

Sample II_3 was purified in exactly the same manner as the combined samples "I" above, converting, however, both crystals and mother-liquor into oxide. That from the crystals being designated II_{3a}, and that from the mother-liquor II_{3b}.

Determinations were made on these samples with the following results:

No.	Samples.	Nb_2O_5 Taken.	Time, Minutes.	$KMnO_4$ c.c.	Nb_2O_5 per c.c. of Sol.	Nb_2O_5 per c.c. N/10.
40	I_A	.2015	6	27.90	.007221	.007038
41	I_A	.2017	7	27.85	.007242	.007059
42	II_{3a}	.2055	13	27.70	.007419	.007231
43	II_{3a}	.2090	15	27.80	.007518	.007327
44	II_{3b}	.2223	16	30.55	.007277	.007092
45	II_{3b}	.2431	17	33.60	.007235	.007052

As was expected, sample I_A showed the effect of purification, giving results which agree, within the experimental error, with those of samples II_1 and II_2. Similarly, sample II_{3a} indicates the presence of tantalum in the product, whereas sample II_{3b} showed the same degree of purity as samples II_1, II_2 and I_A.

Degree of Reduction of the Niobium. — The N/10 factor of the potassium permanganate solution was 1.0260.

1 c.c. of this solution = .007232 Nb_2O_5.*

1 c.c. of N/10 solution = .007052 Nb_2O_5.*

* This result is the average of the values obtained for samples I_A, II_{3b}, II_1 and II_2.

Molecular weight $Nb_2O_5 = 267$.

Hydrogen equivalent of Nb_2O_5 when reduced under the specified conditions $\frac{.0267}{.007052} = 3.786$.

Moles of oxygen required to oxidize the product resulting from the reduction of one mole of Nb_2O_5 under the specified conditions

$$= \frac{3.786}{2} = 1.893.$$

$$5 - 1.893 = 3.107.$$

Therefore, Nb_2O_5 is reduced to $Nb_2O_{5-.107}$, corresponding nearly to the oxide $Nb_{20}O_{51}$.

Reduction by Adding Unamalgamated Zinc to the Solution. — It was thought that there might be some advantage in reducing the niobium solution in a flask with zinc instead of by means of the Jones reductor. A blank determination was therefore made on the zinc as follows: Eight grams of C.P. 20-mesh zinc was added to a flask containing 40 c.c. of concentrated sulphuric acid and 160 c.c. of water, heated to 70° or 80° C. and an atmosphere of carbon dioxide maintained. When the zinc was completely dissolved the solution was titrated in an atmosphere of carbon dioxide. Required 0.2 c.c. $KMnO_4$.

A similar experiment using a solution containing .2000 gram of Nb_2O_5 required 3.3 c.c. of $KMnO_4$, while it should have required nearly 30 c.c. if the reduction had been complete.

Another experiment using 10 grams of zinc and .2051 Nb_2O_5, heated to 90° C., required 8 c.c. $KMnO_4$.

Another experiment using 5 grams of 80-mesh zinc, and maintaining an atmosphere of hydrogen, required 1 c.c. of $KMnO_4$ solution for .1490 gram of Nb_2O_5 taken.

It is our opinion that the failure of these experiments in the reduction of the niobium was due to the fact that with the quite strong acid necessary in the solution the action on the zinc was so very rapid that the process could not continue for a sufficient time to effect any considerable reduction of the niobium without adding an excessive quantity of zinc.

Mixtures of Niobium and Tantalum. — Mixtures of Nb_2O_5 and Ta_2O_5 were next analyzed as indicated below:

The Ta_2O_5 employed in these mixtures was passed through the reductor as a blank experiment and the potassium permanganate solution used in the titration (0.2 c.c.) deducted.

No.	Nb_2O_5 Taken.	Ta_2O_5 Taken.	Time, Minutes.	$KMnO_4$ c.c.	Nb_2O_5 Found.
46	.2051	.050	15	27.15	.1972
47	.2195	.050	8	29.90	.2171
48	.2039	.050	6	27.40	.1990
49	.2024	.100	9	27.50	.2001
50	.2008	.100	8	27.50	.1997
51	.1175	.100	12	15.80	.1148
52	.1098	.100	9	15.60	.1133
53	.1116	.100	5	15.10	.1097
54	.1394	.200	10	19.30	.1401
55	.1288	.200	6	17.00	.1235
56	.0513	.200	7	6.85	.0498

Analysis of Minerals.

The method was next applied to the analysis of minerals, and for comparison, the minerals were also analyzed by the fractional crystallization method, details of which follow:

Crystallization Method. — Fuse 1 to 2 grams of the mineral with 8 to 10 parts of potassium bisulphate. Boil with water until completely disintegrated and filter, using a rubber funnel. Wash with hot water until the washings give only a faint test for sulphates. Wash on the funnel with several portions (15 or 20 c.c. each), of yellow ammonium sulphide, hot, mixing on the filter as much as possible to get the best action. Wash with hot water until free from ammonium sulphide, then with dilute sulphuric acid to remove iron sulphide, then with hot water to remove sulphuric acid (the residue on the filter paper should now be pure white and contain nothing but silica, niobic and tantalic acids). Dissolve through the filter by means of warm dilute hydrofluoric acid.*

Add potassium fluoride approximately equivalent in weight to that of the sample taken. Evaporate on a water-bath until the mass just solidifies on cooling. Dissolve in the smallest possible quantity of boiling hot water. Set aside to crystallize. The tantalum crystallizes as K_2TaF_7, in the form of needles. The niobium crystallizes as $K_2NbOF_5.H_2O$, in the form of plates. These crystals must be carefully examined, using a magnifying glass if necessary, to determine whether they are needles or plates or both. The first crop of crystals is nearly always needles, *i. e.*, free from niobium. If there are no plates, filter on a small paper, using a rubber funnel, catching the filtrate in a platinum dish, and wash sparingly with water slightly acidified with hydrofluoric acid and

* Any dark colored residue indicates incomplete decomposition of the mineral and the residue must be ignited, fused and treated as before.

containing about 1 gram of potassium fluoride per 100 c.c. Evaporate the filtrate to dryness exactly as before, take up in boiling water, etc., filtering off the needles (if free from plates) through the same funnel used for the first crop of crystals. This operation is repeated until a crop of crystals is obtained which consists of a mixture of needles and plates. When this mixture is obtained, add gradually a little of the wash water (1 or 2 c.c. at a time), stirring until the plates disappear. Filter off the needles as before and wash sparingly with the washing solution. The filtrate should now contain all of the niobium, and the crystals on the filter, all of the tantalum as the double fluorides. Dissolve the tantalum salt from the filter, using boiling hot water and adding a few drops of hydrofluoric acid, the latter being necessary to prevent the formation of an insoluble tantalum compound. Add sulphuric acid to both the niobium and tantalum portions and evaporate to copious fumes of SO_3 to remove fluorides and boil with a considerable amount of water. Each element is precipitated by this boiling as its respective oxide, or hydrated oxide, insoluble in water. Filter, wash with hot water, ignite 10 minutes with a blast lamp, and weigh.

Remarks. — Evaporation of the fluoride solution must be carried on with great care, for if carried too far the salts (especially the tantalum) are apt to become partially decomposed and thereby rendered insoluble in water. If evaporation is not carried far enough, too much hydrofluoric acid remains which would cause the niobium to crystallize in the form of prisms, instead of plates, which are difficult to distinguish from the needles of the tantalum salt.

Volumetric Method. — Fuse from 0.2 to 1.0 gram of the mineral with 5 to 10 grams of potassium bisulphate and proceed in exactly the same manner as with the crystallization method to the point of dissolving the precipitate from the paper with hydrofluoric acid. To the hydrofluoric acid solution, containing the niobium and tantalum, in a platinum dish, add 10 c.c. of concentrated sulphuric acid. Evaporate to copious fumes. Add a few c.c. more of sulphuric acid and repeat the evaporation to dense SO_3 fumes. Allow the solution to cool, and pour into cold water, washing the dish well, and add cold water to a volume of about 500 c.c. Heat to boiling and boil for a few minutes. Filter, wash with boiling water until only a faint test for sulphate. Ignite ten minutes with a

strong blast and weigh. This gives the weight of the combined oxides Nb_2O_5 and Ta_2O_5. Fuse with 5 grams of potassium bisulphate. Add 10 c.c. of concentrated sulphuric acid and heat gently to a clear solution. Transfer to a beaker, rinsing out the crucible with 30 c.c. of concentrated sulphuric acid. Allow to cool.* Add 2 grams of succinic acid and agitate, add about 20 c.c. of saturated aqueous solution of succinic acid in a fine stream from a wash bottle, keeping the solution in motion to assist solution of the succinic acid. Add water gradually to a volume of 200 c.c., constantly agitating the solution. Heat to 75° C., reduce and titrate as described on page 326.

No.	Sample.	Volumetric.		Crystallization.	
		Nb_2O_5 per cent.	Ta_2O_5 per cent.	Nb_2O_5 per cent.	Ta_2O_5 per cent.
57	A	53.52	22.84	57.13	21.09
58	A	54.06	22.69	56.82	21.30
59	A	54.42	22.40		
60	A	54.84	23.08		
61	B	27.11	54.27	31.63	50.36
62	B	27.44	53.91	30.24	51.24
63	C	14.39	67.86	17.85	64.63
64	C	14.30	68.26		64.41
65	D	17.27	53.21	26.66	43.43
66	D	16.48	53.92	27.03	43.98
67	D	16.32			
68	D	16.07			

Sample "D" contains quite large amounts of tin, difficult to separate from the niobium and tantalum, as experience has shown. This tin accumulates in the niobium portion in the crystallization method, thus causing high results for niobium. In the volumetric method the tin has no effect on the determination of niobium, but would cause the tantalum (estimated by difference) to be too high.

Comparison of Volumetric and Crystallization Methods.

Columbite A was analyzed again in triplicate by the crystallization method. The niobium and tantalum oxides obtained as a result of these analyses were individually fused and analyzed for niobium by the volumetric method giving results shown below.

Nb_2O_5 is here shown to be present in the tantalum portion (as obtained by the crystallization method), and although no direct tests could be applied for the determination of the Ta_2O_5 in the

* Any cloudiness indicates incomplete decomposition of the oxides.

niobium portion, the results of titration show beyond reasonable doubt that it was present.

The average of these volumetric determinations gives 54.73 per cent. for Nb_2O_5, whereas the average of the results obtained by the regular volumetric method (page 332) is 54.21 per cent. Nb_2O_5, sufficient evidence to show that the results obtained by the crystallization method are in error.

	Crystallization Method.					Volumetric Method.			
No.	Mineral Taken.	Nb_2O_5 Found.	Ta_2O_5 Found.	Nb_2O_5 per cent.	Ta_2O_5 per cent.	From Nb_2O_5 Portion Nb_2O_5 Found.	From Ta_2O_5 Portion Nb_2O_5 Found.	Nb_2O_5 Total.	Nb_2O_5 per cent.
84	.5873	.3294	.1136	56.09	19.35	.3164	.00289	.3193	54.37
85	.5737	.3198	.1185	55.74	20.65	.3089	.00723	.3161	55.10
86	.5264	.2995	.1080	56.89	20.51				

Conclusions.

1. A potassium sulphate-sulphuric acid solution of niobium and tantalum, to which succinic acid has been added, may be diluted considerably and heated without precipitation of compounds of either element.

2. The niobium of this solution may be reduced by passing the solution through a Jones reductor, after which the niobium may be determined volumetrically with potassium permanganate solution.

3. Neither the tantalum nor succinic acid are affected by the processes of reduction and oxidation as carried out in this method.

4. The temperature of the niobium solution during reduction should be 75° C., and the niobium should be titrated at once, the whole operation being carried out in an atmosphere of carbon dioxide.

5. The degree of amalgamation of the zinc used in the reductor is of great importance, the proportion adopted being 600 grams of C.P. 20–30-mesh zinc to 0.5 gram of mercury.

6. The method of fractional crystallization is at best only an approximate separation of niobium and tantalum. Some tantalum remains in solution with the niobium, and a little niobium is held by the tantalum.

7. The volumetric method gives lower results for niobium, and correspondingly higher results for tantalum, than the crystallization method.

8. The volumetric method is not extremely accurate, but is much more accurate than the method of crystallization, and may be carried out in considerably less time.

9. Under the conditions adopted, the niobium is reduced to a degree indicated by the oxide $Nb_2O_{3.107}$ (*i. e.*, 1 c.c. of N/10 potassium permanganate solution equals .007052 Nb_2O_5).

QUANTITATIVE LABORATORY,
March, 1909.

THE WATER-FRONT OF NEW YORK CITY.

By J. A. BENSEL.

In the municipalizing of the water-front of the city of New York begun in 1870, the state made a grant of all the lands under water to the city and continued this policy in the first enlargement of New York city and the borough of the Bronx. In the charter covering the greater city, however, this policy was not continued and the state lands in the boroughs of Richmond, Brooklyn and Queens have not as yet been ceded to the city of New York. This policy of continuing to grant lands under water to private individuals will eventually make acquisition to the water-front of Brooklyn and Staten Island a much more costly proceeding than has been the case in the development of Manhattan Island, and it is, therefore, in my opinion, contrary to the interests of the public and especially of that public with manufacturing and shipping interests. A spirit of sanity and common sense should be encouraged along the lines of municipal operation which has not heretofore been apparent. It certainly is not so if when bridges have been built to connect the two boroughs, the voice of the people is heard demanding that the ferries be operated in the same manner as before, and that, if the owners of the ferry systems will not as a matter of patriotic principle continue the operation at a loss, it becomes the duty of the city to do so. There is, of course, something to be said on the subject in favor of those interested in routes of travel formerly contiguous to the ferries, but any large improvement made along certain lines for the benefit of the whole has always operated to some extent, in interfering with former methods of travel and profit. In the same way it has never been seriously considered that the withdrawal of numerous canals throughout the country, made necessary by the competition of the railroads, imposed thereby a duty upon the state to continue their operation at a loss and by taxation upon the people as a whole. This duty of the city or the state to preserve certain lines of activity is one that has got to be reckoned with in the near future owing to the rapid changes which are bound to occur.

We have recently, in the city's affairs, passed through a

strenuous period trying to identify that elusive microbe of mathematics called the "debt limit," which after several trials and experiments by different parties, has been officially placed somewhere between eight and one hundred and sixty millions of dollars. This wide variation in result of what might be considered an easy calculation in mathematics, shows the need of men in your profession identifying themselves with the whole problem of government, so that we may eliminate, as far as possible, the political ciphering and get to a sane method of calculation which though it may vary to some extent, owing to honest differences of opinion, will rest upon some reasonable basis.

One of the most important things for the engineer of the present time to realize is that the profession has arrived, in some sense, at the parting of the ways, and that, either the engineer is going to make himself felt as an important part of the social edifice, or is to become the unknown advisor as to a great extent, he is at the present time, of those prominent in the conduct of affairs. The reason for this state of affairs may be readily understood if it is considered that heretofore the engineer in the development of the country has been almost altogether relegated to a position on the outskirts of civilization. These barriers, however, have now been removed. There are no longer in this country, at least, any outskirts of civilization, and it therefore becomes, in my opinion, imperative for the proper conduct of the government, that the engineer should take his place where he belongs, as a director in the conduct of affairs.

For many years I have been interested in the development of this port, but it is not my purpose to weary you by quoting figures or statistics trying to prove either that New York is the only city fit to work in, or that on account of the decrease in the ratio of this port's commerce to that of the general country, there is nothing left to look forward to but the gradual extinction of the port. Either of these points of view can be proven to the satisfaction of those who care to make the effort, and as an engineer I would have you give most serious consideration to the old saying that, "nothing is so false as facts, except figures."

The city of New York has been conceived of by many as being the whole port. A glance from the windows of this university will show you to what an extent this is not true, and while the voice of the people may be heard more loudly in that portion of

the port comprised within the city limits, the facts are that one of the most necessary elements of all the port interest for consideration is that almost entirely in the hands of the railroads which lie within the state of New Jersey. An extremely narrow point of view sometimes taken is that all the impovements in New York should be carried on without relation to our adjoining neighbor, and to the extent of the municipal building and operation of means of transit either by ferry or railroad, this narrow point of view must prevail. At the same time it is impossible to conceive of the existence of this city without the communications which are now established with the Jersey shore, nor could the population now living in this city be able to exist without the railroad communication with this city along the water front of New Jersey. This point of view is one that can be arrived at without any political consideration, and it is because of the fact that the problems of civilization that we meet with in this city are impossible of elucidation from any narrow point of view that I think it is necessary for the engineer, who, above all, must consider absolute facts to take up the burden which is laid on him of trying to solve the proper method of government in the city by the consideration of all of the facts which are pertinent thereto. People who are educated to consider facts in their proper relation to mankind are the people who are going to be able to make the government of the city a practical proposition, and not those who are by necessity, environment and education only able to consider those facts which affect the particular political entity of which they happen to be a part.

The city of New York, while it does not contain all of the shore fronts of the port as above stated, is in reality the reason for the existence of that portion of the port lying outside of the city limits, and no improvement of the adjoining water front outside of the limits of the city can be made without affecting the interests of this city for good or for bad.

The explanation of the reason for the greatness of New York as a commercial center in the past is often referred to by the fact of its having a magnificent harbor. There is no question about the fact of the harbor, which relatively speaking in regard to other harbors, is in many ways fortunately situated so as to make its development along comparatively easy lines. To my mind, however, the greatness of this city as a commercial center has had little to do with the fact of its having within its limits the harbor of New

York, and a more pleasing, and I believe a truer conception of the case is to consider that New York was made eminent in its position by the character and achievements of its citizens. In the early days its very isolation as an island was prejudicial to its growth, and at the present time all of the engineering expedients are being put into effect in order to try and remove this embargo. This conception is rather pleasing to me, personally, as I think that without the achievements of the engineer it would not have been possible to have developed the city in its present shape. All of the modern developments, the deepening of the channel at the approach to the city, the building of the subways and tunnels to the surrounding territory, the building of the elevated and subway railroads and the erection of the high buildings have all been called into play to remove the embargo placed upon the growth of the city by the obstacles nature set in its way.

The city of New York is the only city which has undertaken the direction, improvement and control of its water front as a special municipal proposition. This municipal operation began in 1870 and doubtless has not yet reached that position which would put it outside the line of criticism. In a broad way, however, it has operated, in the opinion of those principally concerned in manufacture and transportation, to the interests of the city, the state and the country at large, and to some extent has been copied by other ports in this country, with state and dominion control substituted for that of the city.

Regarding the matter of the city's investment in its water front, a fair interest on the money has been returned to the city through the municipalization of its water front, and this interest was considerably larger before the city undertook the operation of the municipal ferries, which to-day are run at an appreciable loss in so far as the difference between their cost of operation and their net return is concerned. Whether, however, this is a good or bad point, would admit of considerable discussion and many different opinions could be found on the subject, just the same as a considerable variety of opinion can be found as to whether the city should derive from each individual section of its water front the highest revenue possible, irrespective of the nature of use to which that section was to be be put. Personally, I am of the opinion that the operation of the ferries of Staten Island and South Brooklyn was one of the wisest things that the city could do. They

have, by this means, made possible the development of Staten Island in a way that was not possible by leaving the means of connection between the borough of Richmond and the borough of Manhattan to be supplied by private interests. While I am not a believer in the municipalization of all sorts and various means of transportation within the city, it does seem probable that certain definite lines of transportation can be carried out by the city even at an apparent loss, which will still operate greatly to the benefit of the city as a whole in raising the value of real estate, in making possible the development of the waste places, and in making possible the real Greater New York in place of an amalgamation of different boroughs whose interests are not in any way the same.

In this hemisphere the port of Montreal has been improved and developed by the dominion government at the expense of the whole people within that dominion, and the development of the city of Boston has taken place from funds derived from and under a board appointed by the state; and in the city of San Francisco the state operates there a board in the control of a considerable portion of the water-front of the harbor. All of these schemes, including the municipalization of the water-front of New York itself, while varied in their method are really born of a desire of the people as a whole to see to it that the ports of the country are not allowed to be treated as points where commerce may be throttled, but that they should be developed along lines for the best interests of the whole of the people, of the state and country.

In Europe the general development of the ports has progressed along more diversified lines, the control of the port of Liverpool being divided by representation in a board of control of the government and representatives of the commercial interests. The port of London, one of the oldest in the world, was held in private control exclusively until recent times, and its backwardness in development has been such as to make it necessary for the government to contemplate at the present, its improvement from the condition of semi-decay to one capable of handling the largest ships built, by an expenditure, estimated at six hundred millions of dollars.

Complaint is heard from time to time, and doubtless will be continued, of the loss of business at the port of New York. Like all live organizations, this port goes through the necessary changes which inhere to live concerns. There is no absolute loss but there is a relative loss, and this can no more be stopped than it would be possible to throttle the development of other portions of the

country not tributary to the port. The changing conditions of the country are such, and this is said with particular reference to the rapid changes that are occurring in the development of the productive areas for wheat and other products, and the movement of the centers of population such that the natural outlet for the different products of the country must shift from time to time from one port to another. Time was, and not so very long ago, when this port shipped abroad a large amount of wheat. Changes, however, in the area of production of this commodity have made it a more practical proposition to ship from the ports of Montreal, Newport News, and even New Orleans, wheat which, had these not been possibilities, would have come through the gates of New York. It is, however, to the advantage of the country as a whole that other ports should receive their dues from those areas of production which find their way by natural means to the nearest outlet, and all that can be said about the loss of relative importance of the port of New York is, I think, that such changes are occurring along purely logical lines, and that while New York has lost its relative position, it is by no means going backwards, but shows a continual growth in its business. The problem which is before the city in the further development of its water-front, is one which is before us in the development of all of the city's business. It is going to be necessary to multiply the use of the water-front at various localities, in so far as its handling capacity is concerned. There is no lack of water-front still undeveloped. There is, however, congestion at various points much the same as occurs along the various streets of the city used for other purposes. It may be said that there is no congestion in the city as a whole, but there seems to be a desire on the part of certain businesses to continue at localities where they were first founded, and this is met in property in general by the building of larger habitations and stores, and must be met on the water-front by the use of appliances which will enable more tons of freight to be handled than has previously been the case. The handling of freight, to a large extent, even in the congested points of the city's water-front is in a state of archaic simplicity. Nothing, to my mind, would be gained by the contemplation of schemes of sub-surface transportation of freight from either the Jersey meadows or from the water-front to various localities for direct distribution.

Efforts are made from time to time to try to convince the people of this city that the one thing to be overcome is the fact that the

city is surrounded, as far as Manhattan Island is concerned, by water, and that the best thing that can be done is to remove the obstacle of such a means of division from the mainland. To my mind, the condition in so far as the water front is concerned, puts New York in an ideal state as regards the handling of freight in the surrounding territory. Nothing could be better than that the shores of New Jersey should be as they are — one vast railroad yard offering facilities for transportation by water — the cheapest method, to any section of the city where the call may be made, and no number of tunnels under the river for the handling of freight can be compared in economy to the cheap method of handling by lighter or car-float. In the handling of the packages themselves, the city is far behind other ports, due to some extent to the fact that developments for cheap handling of freight have been almost altogether along special lines for particular classes of freight, and no scheme has as yet been developed which can economically handle the mass of freight arriving at one pier, consisting of all kinds, sorts and sizes of materials. The necessities of the case, however, will probably develop in the future the necessary means for meeting the conditions as they have in the past, and I know of no better way to emphasize the lesson than to note the development along certain sections of the East River water-front within very recent times. At the particular localities of which I speak — 39th Street and 74th Street — the nature of the current, the small length of the pier and the isolation of the property in the rear of the water-front is such as to have put it well outside of all possibility of improvement along older lines. In the growth of the electrical industries, however, this section of the water-front of the city was found to be ideally located, for the needs of the electrical industry, and today we have the Edison Company plant, practically the largest in the world for the production of light, heat and power, operating at 39th Street; and the elevated power-house, operating in its ideal location, at 74th Street, thus dispensing with the necessity for the transportation of coal direct to the consumer and the consequent hampering of the growth of various industries.

More and more it is becoming necessary to improve the water-front of Manhattan Island for the necessities of the residents of the city itself, and to a considerable extent the further development on the water-front of Manhattan Island has got to be along the lines of furnishing the necessities of life to the residents of the city rather than to the expansion of the trade of the port as a whole.

THE ETHICS OF THE ENGINEERING PROFESSION.*

By BENJAMIN B. LAWRENCE.

I presume I am addressing students of, and those interested in, mining engineering as a profession; others will, I am afraid, find what I have to say uninteresting.

I am asked to say a few words to you in reference to a question which is of great moment to all professional men — "professional ethics." This question affects the engineering professions, and particularly mining engineering, more deeply perhaps than any other question, and its influence upon the career of young men who make the profession of mining engineering their life work is far reaching.

To put the case plainly before you, let me cite some examples.

Let us assume that you are a graduate engineer, and that you are in the field as a professional man — as a mine superintendent, we will say. Some of the practical problems that you will have to face, are:

1. Have you the right to invest in, buy or sell stock in the corporation which you represent as superintendent?

2. Are you at liberty to invest in, buy, or take any interest in territory or mining claims immediately adjoining the property of which you are superintendent?

3. Are you at liberty to give information as to the operations of the company that you represent to personal friends, or to any others than officers or directors of the company?

Now, if you will consider these questions for a moment, you will see that they bring you face to face, not only with a question of professional ethics but of morality, namely, do you propose to bend your energies towards making a reputation as a conservative mining engineer, or will you use that profession and its opportunities purely for the advancement of yourself in the world along commercial lines?

It seems to me that the tendency of the times is to money

* Address delivered at the Columbia University Chapel on April 30, 1909, at the request of the Chaplain of the University.

making, and to make it as quickly as possible, to the neglect of making reputation and depending upon *that* for making money *afterwards*.

Now, to return to the three questions that I have mentioned:

1. Is a mine superintendent at liberty to buy or sell stock in the company which employs him?

In my opinion it is far better that he should have no interest whatsoever in the stock of the company of which he is superintendent. I say this advisedly and after mature consideration. I have in several instances bought stock in the company which I represented, but in each case I found that it was a mistake — not only from the point of view of my advancement in the world, but also morally. Self-interest is an enormous factor, and a mining engineer, with the control of the property in his hands, must necessarily have much difficulty in choosing the right path. You are often isolated from the world in a new environment with no adviser at hand, and you find yourself face to face with this moral question, and a pretty serious one, at the outset of your career. My advice to you is not to buy stock, or be interested in any way in the stock of the mining corporation which you represent. Ask for a salary sufficient to make you feel that you are being well paid for your services. You will find that the officers of a company will recognize these services if you are worthy, and they will respect you all the more for not dealing in or owning the stock of the company.

2. Is one at liberty to invest, buy, or take any interest in territory or mining claims immediately adjoining the property of which he is superintendent?

Again we have a very serious question to deal with, and again I must assert that in this question the same moral principle is involved — as mine superintendent you see that the vein is leaving your lines and that it will soon enter the adjoining property. This knowledge, which it may occur to you to take advantage of, really belongs, if you stop to think of it for a moment, to the owners of the property which you represent, for you have gained it while in their employ. It is your duty, then, to report the situation to the owners of the property, and first give them the opportunity of profiting by this information, and if they fail to take advantage of it, you are then at liberty, at your discretion, to become owner in part or in whole of adjoining property.

I have seen so many cases where mine superintendents, from ignorance or lack of forethought, have failed to report the advantages of taking up adjoining territory to their principals, thinking that they would ultimately become possessed to it themselves, that it is high time that this matter was discussed by mining engineers, and that you should take a stand directly against any such procedure.

As to the third question — giving information to outsiders and friends as to your operations. This is a bothersome question which has often come to me.

A mining engineer is naturally proud, or at least should be proud, of his achievements, and is quite anxious that his friends should know and appreciate what he is doing. It is wise, however, under these circumstances, that you should at the outset have a very clear understanding with the owners of the property as to how far you may go in reporting the situation at the mine to your engineer friends, or if you may write on the subject for journals, college papers, etc. My advice is that you should discriminate in this matter.

A man of intelligence can readily discern whether his questioner wishes to secure information to use for commercial purposes, or for purely scientific purposes. Every engineer should be at liberty to give to the world through scientific papers and mining journals such information as he can give about the mine he is operating. In fact, it is his duty to do so. It is only through coöperation among engineers that we get anywhere. He should make it his duty and business to inform his fellow engineers of any geological occurrence which is unusual, or any method of mining or treating the ore which he thinks is beneficial. But he must also remember that this information can be given without touching upon the commercial side — value of ores, etc. — or giving any light upon his operations which can be taken advantage of by the stockbroker or persons desirous of speculating upon this information.

Among other pitfalls laid for the unwary is the suggestion to the engineer that a favorable report upon the property is desired. As you know, in order to dispose of a mine it is necessary in these days to have an engineer's report. You can well understand how dangerous it is to agree in advance to make a favorable report, even if you do know of the property favorable. Unfortunately there are many in the profession whose reports in consequence

have no value to the investor. They have acquired the habit of making favorable reports.

This is on a line with the acceptance of a contingent fee based upon the sale of the property if your report is favorable. It is just as well to make up your mind to accept no contingent fees which are dependent upon the sale of the property. One of the ethical questions of the profession which is constantly being violated is the result of the temptation which comes to all engineers to interest themselves in the sale or promotion of mining properties. You cannot serve two masters. You cannot expect to excel in the profession and at the same time be a promoter. The engineer should be unprejudiced, unbiased, courageous with the courage which the real love of the profession gives.

I think I have pointed out to you the necessity that a mining engineer should be above reproach in all professional matters. As your chaplain will tell you, there is only right road, and that is the straight and narrow one, and the mining engineer's life is so full of temptation and opportunities to "get rich quick," and there are so many rough roads to travel, that one cannot but preach a little bit on the necessity of following along conservative lines in the practice of your profession. Do not be in a hurry to become famous or rich, as it is only through long, painful experience that most of us can obtain any foothold, and your experience in the field must necessarily be in the nature of character formation as much as anything else.

The School of Mines has stood for the best and highest in the profession of mining engineer. Its founders have reason to be proud of the men who have represented their alma mater in the field. Columbia has furnished men to the mines of the world.

ABSTRACTS—ANALYTICAL CHEMISTRY.

By E. WALLER.

Potassium in Soils. Shedd (*J. Ind. and Eng. Chem.*, I., 302). Treat 1 gm. of the soil by the J. L. Smith method (heating with 1 gm. NH_4Cl and 8 gms. pure $CaCO_3$). Having obtained the solution of chlorides from this treatment (about 200 c.c.), in the manner prescribed by J. L. Smith, acidify with acetic and evaporate to 10 or 15 c.c. Then add 10 c.c. or a positive excess of Drushel's cobalti-nitrite reagent and conduct the analysis (volumetric) as described in his paper (vid QUARTERLY, XXIX., 373).

Lime in Presence of Calcium Carbonate. Heyer (*Chem. Ztg.*, XXXIII., 102). In a 500 c.c. flask shake up 2.5 gms. of the sample with 125 c.c. water. Then add 125 c.c. of 2 per cent. NH_4Cl solution, stopper, and shake at intervals for some time. Then dilute to the mark, mix well, and allow to settle. Withdraw some aliquot part of the clear solution and titrate with N/10 acid. The alkalinity represents CaO as $CaCO_3$ does not react with NH_4Cl in the cold.

Calcium in Magnesite. Hundeshagen (*Zts. off. Chem.*, XV., 85). Boil 1 gm. of the sample with 80 c.c. of 5 per cent. HCl for 15 minutes — filter, evaporate to dryness, and take up with 30 c.c. of warm water containing 4 gms. Na_2SO_4. Then add 40 c.c. of 90 per cent. alcohol, stir in well, and set aside at 17° to 20° C. for 5 hours. Crystalline $CaSO_4$ separates out, which after washing with 50 per cent. alcohol is dissolved in HCl, and the Ca determined as oxalate in the ordinary manner.

Alkaline Earths — Separation. Ebler (*Zts. anal. Chem.*, XLVIII., 175). The method is based on the insolubility of $BaCl_2$ in strong HCl. The mixed carbonates (Ca, Sr and Ba) obtained in the usual manner with $(NH_4)_2CO_3$, are dissolved in as little dilute HCl as possible, then ten times the volume of cold 10N/HCl is added, and after thorough agitation, is filtered at once through a hard filter moistened with conc. HCl.

Iron in Brass and Bronze. Bregowski and Spring (*J. Ind. and Eng. Chem.*, I., 187). In many cases about half of the iron content of such alloys will be found to have followed the Sn appearing in the SnO_2 weighed up. It may be recovered and determined by fusing with Na_2CO_3 and S, and to the solution adding NH_4Cl to separate out the FeS, the treatment of which is obvious.

Iron Titrations — Copper as Reducing Agent. Birch (*Chem. News*, XCIX., 273). The use of Cu foil or sheet is recommended as superior to Zn. Five minutes boiling has been found to be amply sufficient. It is advised to use "pure electrolytic" Cu foil of such a thickness that 100 sq. cm. weigh about 6 gms. Cut into pieces about 2 × 2.5 cm., bend each piece at right angles in the middle to prevent "matting."

Put 25 to 30 pieces of this in a round-bottomed flask — wash first with a little dilute HNO_3, then with dilute H_2SO_4, and then pour in the (acid) solution to be reduced. Boil gently for five minutes, cool under the tap, pour off into another flask, rinse three times with distilled water and then proceed to titrate. Dropping in a fragment of calcite is a good plan to prevent reoxidation. The Cu only dissolves in proportion to the Fe reduced, and may be used again and again until quite thin.

Chromium as Chromate. Wood and Weed (*Zts. anorg. Chem.*, LIX., 94). CrO_3 can be determined accurately as Ag_2CrO_4 if an excess of $AgNO_3$ is used, and after precipitation the solution should be rendered slightly alkaline with NH_4OH and then slightly acidified with acetic. Filter on a tared filter, wash with very dilute $AgNO_3$ solution, and finally with very little water to remove the $AgNO_3$.

Manganese — Indirect Volumetric Method. Bollenbach and Luchman (*Chem. Ztg.*, XXXII., 1101 and 1114). A standard solution of ferricyanide is used in alkaline solution. Ferrocyanide is formed proportionately to the amount of Mn present, and may be titrated by standard permanganate. The reaction occurring is:

$$MnSO_4 + 2K_3FeCy_6 + 4KOH = MnO_2 + 2K_4FeCy_6 + 2H_2O.$$

Nickel — Electrolytic. Schumann (*Zts. angew. Chem.*, XXI., 2579). Comparison is made of a number of the methods prescribed by different analysts. Electrolytes containing citric acid always yielded results about 0.5 per cent. too low. In general it is found that chloride, nitrate or sulphate may be present in the electrolyte provided it is strongly ammoniacal, and $(NH_4)_2SO_4$ is present.

Nickel in Presence of Cobalt. Sanchez (*Bull. Soc. Chim.*, V., 641). The sulfides of the $(NH_4)_2S$ group are treated with HCl to dissolve off the other metallic sulfides and leave the mixture of CoS and NiS. Dissolve in aqua regia and evaporate to dryness. Redissolve in as little water as possible, neutralize with alkali, and then add cautiously and slowly a 10 per cent. solution of KCy from a burette, until resolution occurs. Evaporate to dryness agitating the liquid constantly to favor the oxidation of the Co compound to cobalticyanide. Evaporate to dryness. [In this when dissolved, $AgNO_3$ will produce a precipitate of $Ag_6Co_2Cy_{12}$ with AgCy, the Ni remaining entirely in solution as $Ni(NO_3)_2$.] Dissolve in 20 c.c. of hot water, and add ten volumes of 10 per cent. $AgNO_3$ solution for every volume of KCy solution used. Heat and stir the solution, finally washing by decantation with boiling water. To the united filtrate and washings add 14 per cent. KBr solution in equal amount to that of the $AgNO_3$ solution used (*e. g.*, if 1 c.c. KCy were used, use 10 c.c. $AgNO_3$ and 10 c.c. KBr solutions). Only Ni now remains dissolved, the Co being in the precipitate.

Filter off the AgBr, wash several times with boiling water, bringing the bulk of the clear solution up to 300 c.c. Add excess of NaOH or KOH to precipitate the Ni, and then Br water to convert it to Ni_2O_3, boil 10 or 15 minutes, filter and wash thoroughly, then put filter and precipitate into an Erlenmeyer flask, add 5 c.c. of 20 per cent. KI and

5 c.c. of 20 per cent. H_2SO_4 and titrate the I liberated by the Ni_2O_3 with N/10 $Na_2S_2O_3$.

Zinc — Delicate Qualitative Test. Del Campo (*Anal. Fis. Quim.*, VII., 63). Add to an ammoniacal solution containing Zn, 1 c.c. of a 0.5 per cent. ether solution of resorcinol. A deep blue coloration develops at the line between the two layers of liquid, either immediately, or in a few minutes. If the proportion of Zn is very small (0.005 mgm. per c.c.) it will not be perceptible before an hour has elapsed. Cd salts show a green color under these conditions. Cu salts give a black precipitate. In presence of Cu the test may be made for Zn by previously decolorizing by dilute KCy, of which no more than is absolutely necessary must be used.

Zinc Ferrocyanide. Rupp (*Chem. Ztg.*, XXXIII., 3). The Zn solution is made as neutral as possible and Rochelle salt added. It is then mixed with a known volume of ferrocyanide solution, dilute to 50 or 100 c.c. and allowed to stand about half an hour for formation of the denser $K_2Zn_3(FeCy_6)_2$. Then an excess of N/10 I solution (measured) is stirred in and the mixture allowed to stand for an hour, when it is titrated with $Na_2S_2O_3$. Ferricyanide results from the action of the I on the K_4FeCy_6. 1 c.c. N/10 I = 0.00981 Zn.

Tantalum Ores. Simpson (*Ch. News*, XCIX., 243). One part of the mineral (which has been passed through a 90 sieve) is fused in a nickel crucible with six parts of KOH at a low red heat. Decomposition will be effected as follows:

Manganotantalite in 10 minutes.
Ferrotantalite, Euxenite, Fergusonite, Stibiotantalite } in 20 minutes.

Cassiterite finely ground in agate requires 45 to 60 minutes. This fusion is for estimation of Ta_2O_5, Nb_2O_5 and Sb_2O_3.

The melt is extracted with a limited quantity of water. Carbonates and hydrates of Fe, Yt, etc., remain undissolved, but are brought into solution by adding a definite amount of HCl and heating to a boil. On diluting and further boiling hydrates of Ta_2O_5 and Nb_2O_5 are precipitated. The mixed moist hydrates are dissolved in water acidified with HF and separated by adding KF, evaporating and separating the successive crops of K_2TaF_7. The Nb is finally precipitated as hydrate and weighed as oxide, the weight being deducted from that of the combined oxides, determined on another portion, Ta_2O_5 being determined by difference. An allowance is made of 2 mgms. of Ta_2O_5 for every 1 c.c. of the liquor from which the final crystallization of K_2TaF_7 has taken place. The method is described in fuller detail in Bulletin 23 of the Geol. Sur. of Western Australia (pp. 72–74). The results are correct within one per cent., which is as close as is possible in our present state of knowledge of those elements. To estimate Fe, Mn, Yt, etc., the treatment is the same, but a silver crucible is used, and the mixed Ta_2O_5 and Nb_2O_5 precipitated by boiling are rejected because invariably con-

taining AgCl, etc. When Sb is present the whole of that element is with the precipitated oxides, but can be removed by digestion with $(NH_4)_2S$, and then treating the residue by fusion as at first.

Creeping of the alkaline melt can be avoided by fitting the crucible in a hole in an asbestos board, so that it comes through only about a quarter inch. The top is thus kept too cool for creeping. The crucible cover should be convex on the under side that any portions of the melt projected against it shall not find their way to the sides.

When Ti is present, the results for Nb appear to be low, those for Ti correspondingly high. The point requires further investigation.

Electrolytic for Bismuth. Peset (*Zts. anal. Chem.*, XLVII., 401). The difficulty with Bi is chiefly non-adherence and oxidizability. These inconveniences are obviated by covering the metal when precipitated with a coating of a known amount of Cd.

The Bi salt containing 40 to 80 mgs. is heated with 4 to 5 c.c. H_2O and 3 c.c. conc. H_2SO_4, then diluted to 140 c.c. Electrolyze at 50° C. with a cathode of 110 cm.^{2} area, at 2 volts and 0.002 to 0.01 amp. The anode must be constantly rotated to prevent formation of BiO_2. After 18 to 24 hours, when all Bi is shown by tests to have been deposited, add $CdSO_4$ solution containing a known amount of Cd (80 to 150 mgs.). Electrolyze at 2.5 to 3.5 volts and 0.2 to 0.3 amp. for eight hours.

Lead by Peroxide Method. Medell (*Eng. & Min. J.*, LXXXVII., 262). Treat 0.5 gm. of the ore with aqua regia, following it up by H_2SO_4 and evaporate to SO_3 fumes. Dilute and filter. Wash several times with dilute H_2SO_4. Then dissolve what $PbSO_4$ may have got upon the filter with two lots of 3 per cent. NaOH running the solution back into the beaker containing the major part of the $PbSO_4$ mixed with the insoluble material of the ore. Boil, then cool to 90° C., and add 15 to 35 c.c. of a 5 per cent. solution of KBr saturated with Br. Heat for 5 minutes with constant stirring, avoiding expulsion of all the Br. Decant through a filter and wash by decantation. Then treat the precipitate together with the filter in a beaker with 250 c.c. of water and 5 c.c. of the phosphoric acid. Add sufficient standard ferrous ammonium sulfate to reduce the PbO_2 obtained, and titrate back with standard permanganate.

$Fe(NH_4)_2(SO_4)_2.6H_2O$	18.958 gms. per liter	1 c.c. = 0.005 Pb.
$KMnO_4$	1.528 " " "	

Lead. Colorimetric. Woudstra (*Zts. anorg. Chem.*, LVIII., 168). The method by H_2S is inexact in presence of Fe, but in its absence is capable of great accuracy. Of course it is only applicable in the case of very small amounts of Pb. Under such conditions the addition of H_2S affords colloidal PbS. This is coagulated by addition of $BaCl_2$. Then asbestos is added, and the solution boiled, to facilitate filtration. After filtering and washing dissolve in HCl, and evaporate to dryness. The $PbCl_2$ thus obtained is redissolved, and reprecipitated again as above directed. Finally the $PbCl_2$ is dissolved, the solution rendered alkaline and H_2S added. A colorimetric comparison with solutions containing

known amounts of Pb, which have been treated in the same manner, completes the test.

Silver in Gold Bullion. Taylor (*Eng. & Min. J.*, LXXXVII., 543). Method used at Great Boulder Perseverance Mine, W. Australia. Fuse in a porcelain crucible with a little KCy 0.5 gm. of the bullion with 1.5 gms. Cd. After cooling dissolve off the KCy with water, then treat in a flask with 20 c.c. of water, and make four successive additions of HNO_3, the boiling being maintained for an hour. The solution is cooled, diluted, and the Ag determined by titration with standard NH_4CNS.

Gold in Copper Bullion. Hunt (*Eng. & Min. J.*, LXXXVII., 465). Dissolving the Cu in conc. H_2SO_4 affords some Cu_2S in the residue. If, however, some $CuSO_4$ is used with the acid but little sulphide is formed. Hence treat 1 assay ton of the borings with a mixture of 80 c.c. conc. H_2SO_4 and 25 c.c. of a 16 per cent. $CuSO_4$ solution. When action stops, cool — stir in 400 c.c. water, bring just to a boil, and filter. Dry and ignite the filter, and then scorify with 35 gms. Pb and 1 gm. SiO_2. Cupel and part. If Ag is to be determined, oxidize the filtrate with $KMnO_4$, add 1 c.c. of saturated solution of NaCl, then 10 c.c. of ten per cent. $Pb(C_2H_3O_2)_2$, let stand over night, filter, and add the precipitate to that containing the Au, before scorifying down, etc.

Arsenic in Ores — Rapid Method. Hooper (*Trans. Inst. Min. Met.*, XVII., 331). Prepare a solution of $Na_2S_2O_3.5H_2O$. 33.1 gm. per litre 1 c.c. should = 0.005 As. Standardize by use of 0.3 gm. lots of pure Cu (iodine method) or with 0.264 gm. pure As_2O_3 converted to As_2O_5 by evaporating with HNO_3 and heating strongly. Dissolve in NaOH, neutralize with HCl, add KI and titrate.

Treat 0.5 gm. of ore with 10 to 15 c.c. of solution of $KClO_3$ in conc. HNO_3, evaporate to complete dryness, and heat for a few minutes. Cool — add 10 c.c. dilute ammonia, boil gently, then add 25 c.c. of 25 per cent. NaOH, filter hot, and wash with warm water. The solution at this stage should not exceed 50 c.c. If too large evaporate down, acidify with HCl and titrate. Except in standardizing, the author regards the use of starch as unnecessary.

Antimony in Thioantimoniates. Schutte (*Metallurgie*, VI., 214). Al in powder or as shot (but not as sheet) precipitates metallic Sb from strongly alkaline solutions of thioantimoniates. Not quite all the Sb is precipitated. By prolonged action some Sb redissolves. Mg powder acts more completely and can be used as a quantitative mode of separation provided no other members of the group are present. With both metals traces of SbH_3 are formed.

Stibine — Action on Silver Nitrate. Reckleben (*Ber.*, XLII., 1458). Practically all of the text-books state that SbH_3 when passed into dilute $AgNO_3$ affords Ag_3Sb as a precipitate. The author believes this to be true, but that practically immediately a reaction occurs between the Ag_3Sb and excess of $AgNO_3$ which affords Ag and H_3SbO_3, the latter in quite insoluble form, so that but little Sb, though always a perceptible amount, reënters into solution. The reaction therefore is essentially parallel to that with AsH_3.

Separation of Antimony and Tin. Panajotow (*Ber.*, XLII., 1296). If the solution contains 15 per cent. of HCl (Sb being as triad, Sn as tetrad) complete precipitation of Sb alone can be effected by warming to 50° or 60° C. and passing H_2S for 30 minutes. At ordinary temperatures a little Sn comes down also, but at the temperature prescribed, that does not occur. The Sb_2S_3 separates in the dense granular cinnabar-red form, which is readily filtered and washed on a Gooch filter, first with 15 per cent. HCl saturated with H_2S until all Sn is removed, then with water saturated with H_2S, then with alcohol, then with a mixture of alcohol and CS_2, then with CS_2 followed by alcohol, and finally by ether. It is then dried at 110° and weighed as Sb_2S_3. The filtrate is partially neutralized, diluted, and warmed, when H_2S will precipitate the Sn.

Tin on Tin Plate. Delepsen and Meyers (*Zts. angew. Chem.*, XXII., 68). Cover with water, heat on the water bath to 80° C., then add Na_2O_2 (in about the proportion of 1 gm. to every 20 gm. of the tin plate). Heat for 20 minutes, wash the iron thoroughly, dry, and weigh. The loss of weight represents Sn. The results are usually sufficiently exact. With terne plate all the Pb is estimated with the Sn as it dissolves off with it.

Testing Tin Plate. Walker (*J. Ind. & Eng. Chem.*, I., 295). Minute pin holes in the coating are the cause of rusting and deterioration of that kind in tin ware. To test for their presence and frequency the plates are soaked over night in dilute NH_4Cl solution, or dipped for half a minute in 5 per cent. H_2SO_4. A solution made up as follows is then applied:

Gelatine,	50 gms.
Water,	450 "
Potass. ferricyanide,	1 "
H_2SO_4,	1 "

Dissolve the gelatine by the aid of heat. Add the ferricyanide and cool to 40° C., or below, before adding the H_2SO_4. The solution should be made up fresh every time for use, as it alters by standing.

Blue spots develop on the surface of the plate in the course of "30 minutes or so" wherever the "pin holes" exist.

Halogens — Chloride, Bromide and Iodide. Caven (*J. S. C. I.*, XXVIII., 505). Small amounts of Cl may be estimated when mixed with much bromide (*e. g.*, in testing pharmaceutical or commercial KBr) by dissolving a known amount of the sample, running the solution into a 200 c.c. flask, adding enough water with 25 c.c. conc. HNO_3 to bring the total volume to 100 c.c., boiling and then passing a current of air to decolorization. The stem of funnel for introducing the diluted HNO_3 should deliver close to the bottom of the flask. The stopper carrying the funnel should also carry a short tube connected with an aspirator. At first, when heating up, air is gently drawn through the liquid. After boiling one minute and then removing the heat, the current of air is drawn through briskly for five or six minutes while it cools. Br is set free, and if the current of HNO_3 has been suf-

ficient decolorization ensues quickly. All the chloride will remain in the solution, where it may be determined by the Volhard method (NH_4CNS), the AgCl being of course filtered off before the back titration.

With mixed chloride and iodide the result is not quite so satisfactory, some HIO_3 being formed. With a mixture of the three there appeared to be some formation of IBr, which is not so readily removed by the current of air.

To determine all three when mixed:

(i) Determine total halide by the Volhard process.

(ii) Determine I by boiling with H_2SO_4 and iron-alum and titrating the ferrous iron formed. Bromides and chlorides are not affected, the reduction being due entirely to the iodide present, the I being eliminated by the boiling.

(iii) Remove I by boiling with acetic and 0.5 c.c. of 30 per cent. H_2O_2: then remove Br by treatment with HNO_2 as above described, then determine Cl in the liquid remaining by the Volhard method.

(iv) Bromide is obtained by difference.

Chlorates — Colorimetric. Virgili (*Am. Chim. analyt.*, XIV., 85). Prepare a solution of aniline hydrochloride in HCl of Gr. 1.12. The addition of 4 c.c. of this solution to 1 c.c. of a solution of a chlorate affords at first a violet coloration rapidly turning blue. Some time after it fades with formation of a greenish precipitate. For reading the comparison solutions about 25 minutes standing should be allowed. The coloration is proportional to the amount of oxidizing agent present. Free Cl, H_2O_2, etc., will give the same reaction but the process is applicable for the estimation of chlorate if regard is had to that limitation.

Sulfide in Alkaline Cyanide. Ewan (*J. S. C. I.*, XXVIII., 10). A critique on the different methods recommended. (1) The rapid "works" method consists in dissolving 10 gms. of the sample in 15 c.c. of water, and titrating with a standard solution of $Pb(NO_3)_2$ until a spot-test of the liquid shows no brown on a paper moistened with a Pb solution. Some oxidation of the sulfide always occurs. The results should be multiplied by 1.25.

(2) Colorimetric methods are only accurate when the conditions of concentration, presence of certain salts, etc., are identical in the standard solution and the one tested.

(3) Feld's method — distilling with $MgCl_2$ in a current of CO_2 and passing the H_2S into I solution — is accurate but troublesome.

Separation of Sulfates from Fluorides. Ehrenfeld and Indra (*Chem. Ztg.*, XLI., 375). Mix with ten times its weight of Zn dust in a Rose crucible, cover with a layer of Zn dust, and heat half an hour strongly in a current of H or purified coal gas. After cooling, transfer to a flask, add precipitated SiO_2 and finely ground Al_2O_3 to combine with the F. Then run in dilute H_2SO_4 and conduct the H_2S evolved into a known amount of N/10 I solution. Then add a measured amount of N/10 $Na_2S_2O_3$ (in excess) and titrate back with N/10 I.

Nitrites in Waters. Rochaix (*Compt. Rend. soc. biol.*, LXVI., 171). The reagent is 0.2 gm. toluylene red (neutral red) per liter of water.

To 10 c.c. of the water add 20 c.c. of this reagent and 1 to 3 c.c. of 20 per cent. H_2SO_4. Nitrites give a blue coloration under these conditions.

Acidity of Hydrogen Peroxide. Endemann (*Zts. Angew. Chem.*, XXII., 673). Direct titration with N/10 alkali and phenolphthalein indicator gives only half the free acid, the reaction affording Na_2O_2, which acts in this manner: $Na_2O_2 + H_2O = NaOOH + NaOH$. The first of these products is neutral to the indicator. The remedy is to add an excess of the N/alkali and heat after dropping in a bit of platinum (to cause catalytically decomposition of the peroxide), and then titrating back.

Crude Acetate of Lime. Fresenius and Greenhut (*Zts. anal. Chem.*, XLVII., 597). The distillation method, though not perfect, is the best. The crude acetate always contains some volatile substances besides acetic acid. The charge recommended is 5 gms. of sample 100 c.c. of water and 15 c.c. syrupy H_3PO_4 (Sp. Gr. 1.7). Distil repeatedly in a current of air free from CO_2. Titrate the distillate with standard NaOH and phenolphthalein indicator.

METALLURGICAL ABSTRACTS.

By WILLIAM CAMPBELL.

Antimony.

Antimony: E. B. Wilson. *M. and M.*, 29, 476. Gives uses, ores, methods of assaying, the Sanderson and the English processes of smelting.

Uses of Aluminium: J. T. W. Echevarri. *M. and S. P.*, 98, 1909, 424. Physical properties. Maximum load, sand cast, 10,000 with 25 per cent. elongation. M. L. hard drawn wire 30,000 with 25 per cent. elongation. It should not be heated above 725° C. to avoid "burning." Soldering. Various uses.

Copper.

Smelting Conditions at Salt Lake: C. DeKalb. *M. and S. P.*, 98, 23. Discussion of effects of fume litigation. New plant of the Utah Con. The Tintic smelter. The future of Utah as the great smelting center.

The Granby Smelter: R. Keffer. *M. and S. P.*, 98, 1909, 256. Eight 44 × 210 in. furnaces in blast. 24,000 tons in seven days record run. Self-fluxing, 12½ per cent. coke. 3 converter stands. Blister shipped to N. J. Photographs.

Step-toe Valley Smelting Plant, McGill, Nev.: L. Humphreys. *M. World*, XXX., 1909, 273. Sampling plant, Vezin samplers. Concentration, Richards classifiers, Wilfleys. Huntingdon Mills & Wilfleys. Vanners. 6 McDougal roasters, 2 reverberatories and one blast furnace. 3 converter stands.

The Yampa Smelting Co.'s 1000-Ton Converter: C. C. Christensen. *Min. World*, XXX., 1909, 621. McDougal roasters, 3 reverberatory smelters, 3 blast furnaces, 2 converter stands. Illustrations.

The Sasco Smelter and Power Plant, Sasco, Ariz.: S. F. Shaw. *Min. World*, XXX., 1909, 742. Two 350-ton furnaces, 43″ × 192″ × 17 ft. column, 12 × 8 ft. settlers. Two converter stands, matte 45 per cent. Cu to blister; slag 42 per cent. SiO_2, 25 per cent. CaO, 17 per cent. FeO, 5 per cent. Al_2O_3, 0.35 per cent. Cu. Produces over a million pounds of copper per month.

The Cananea Consolidated Copper Co. in 1908: L. D. Ricketts. *E. and M. J.*, 87, 1909, 101. Report on the mines, costs, concentrators, the reduction division. Bedding. McDougall roasters, 6 blast furnaces running, 2 spare. Reverberatory oil fired.

New 506-ft. Chimney at Great Falls Smelter: E. Higgins. *E. and M. J.*, 87, 156. General location, plan of smelter and flue system and section through connecting flue and dust chamber. Description of new chimney, photographs. See *E. and M. J.*, 87, 1909, 323.

Copper Mines in Chillagoe District, Queensland: G. W. Williams. *E. and M. J.*, 87, 1909, 1125. Lead and copper smelter of Chillagoe Railways and Mines, Ltd. Mount Molloy mines; 90 × 36-in. furnace. Matte kept hot in reverberatory till converted. The Einasleigh copper mine, unsuccessful attempt to smelt with charcoal.

A Matte-separating Forehearth: E. Jacobs. *E. and M. J.*, 87, 1232. Settler used at Tyee Copper Co.'s plant at Ladysmith, B. C., gives continuous flow of matte as well as slag. Drawings and photograph.

The Kilker Matte Tapping Car: F. T. Havard. *E. and M. J.*, 87, 1909, 1294. Circular car, 16 tipping moulds, holding about 3,300 lbs., at East Helena. Two are in use at each furnace.

The Rotary Blower in Smelting Works: G. C. Hicks. *E. and M. J.*, 87, 1909, 352. Description of Root's blowers, with illustrations.

Power from Copper Blast-Furnace Gases: R. Schorr. *E. and M. J.*, 87, 1909, 459. At Mansfeld are the Krug-Hütte, Koch-Hütte, Eckardt-Hütte and Kupfer-Kammer-Hütte. Charge nearly 20 per cent. coke. Waste gases used for steam and heating blast. Krug-Hütte equipped with gas engines.

Sintering at Cerro de Pasco: M. and S. P., 98, 1909, 195. The Cerro de Pasco M. Co. has installed 14 sintering furnaces at Tinyahuarca to agglomerate the fine ore passing the grizzlies, and flue dust. Ovens consist of flat grating with hoods above and inlets for air blast. Grates have central axis and discharge by tilting into brick chamber below which acts as storage bin. Not very successful.

Pyritic Smelting by Knudsen Method in Norway: E. Knudsen. *E. and M. J.*, 87, 1909, 1080. At Sulitjelma the process was worked out. When sulphide ores are roasted under a powerful air current the ore melts partially and pure sulphide gathers on the hearth of the furnace. By production of a strong oxidation of this bath of sulphide enough heat is generated to melt the rest of the charge. Furnace a modified converter. Results of experiments are given, with photograph of plant.

Combined Roasting and Smelting Processes for Copper Ores and Fines: Electro. and Met. Ind., VII., 1909, 286. Description of Fink and Catton processes.

The Fink Furnace: F. W. Traphagen. *West. Chem. and Met.*, V., 1909, 172. Brief description of furnace and process.

A Process for the Smelting of Copper- and Nickel-bearing Pyrite: Warlimont. *Metallurgie*, 6, 1909, 83–127. Method of roasting, oven used, etc. Lixiviation. Formation temperatures of iron, copper and nickel sulphates by roasting their sulphides.

Laboratory Routine in Modern Copper Smelters: H. T. Waller. *Bull.* 49, 1908, *I. M. and Met.* Analysis of slags. Determination of Cu, Fe, CaO, Al_2O_3, Zn, S. Analysis of ores and fluxes: of matte.

Copper Rolling Mill Practice: Copperman. *Met. Ind.*, 15, 1909, 4, 64, 98–134. Methods of driving rolls. Brass mills. Comparison of copper and brass mills. Slabbing, roughing and finishing mills. Plate mills. Cold rolling.

GOLD.

Developments in Gold Dredging during 1908: J. P. Hutchins. *E. and M. J.*, 1909, 87, 200. Review of work of year.

The Average Rate of Accumulation and Absorption of Gold Amalgam by Copper Plates: E. Halse. *Bull. 44, I. M. and Met.* (1908). Results of amalgamation in a Columbia mill on 3 sets of electro-silvered apron plates, over a period of more than 6 years.

Ore Treatment at the Giant Mine, Hartley Dist., Rhodesia: R. C. H. Cooke. *Jl. Chem. Met. and M. Soc. S. A.*, IX., 1908, 152. Stamp crushing, amalgamation, tube mills, close concentration on blanket and canvas tables, amalgamation of concentrates after treatment with nitric acid.

The Three Producing Gold Mines of France: E. Walch. *E. and M. J.*, 87, 1909, 792. The Lucette mine one of the largest antimony producers in the world, auriferous quartz and stibnite. Crushers and jigs for antimony ore. Smelted to regulus or roasted to oxide. Rich gold ore to smelters, poor is stamped. LaBellière, quartz and mispickel. 40 stamp mill, roasting and cyaniding. The Chatelet mine, quartz with a little mispickel and gold telluride, mill being installed. Ball mills, Merton furnaces, agitation and Ridgway filters.

Progress in Cyanidation: A. James. *M. and S. P.*, 98, 1909, 47. Slime processes, agitation, vacuum filtration, roasting, crushing, concentration, Adair-Usher process. Clean up.

Cyanide Operations in Mexico during 1908: M. R. Lamb. *M. World*, 1909, XXX., 267. Illustrated description of various changes and methods of work.

The Railroad Systems of Northern Mexico: H. A. Horsfall. *E. and M. J.*, 87, 1909, 712. Contains sketch map showing Chihuahua, Durango, Sinaloa, Sonora and the U. S. boundary.

Milling and Cyaniding at El Oro, Mex.: C. T. Rice. *E. and M. J.*, 87, 1909, 683. Description of the El Oro Co.'s mill, the Mexico Mill, the Dos Estrellas Mill and the Cedro Mill.

Rio Plata Mine and Mill, Western Chihuahua: H. J. Baron. *E. and M. J.*, 87, 147. Description of mine. Map of S. W. Chihuahua. Mill. Flow sheet of concentrating and cyaniding. Card tables, Wilfley slimers, Wheeler pans, Dimmick classifier. Pachuca tank and Moore vacuum filter.

Santa Barbara Mine: M. and M., 29, 369. Description of mine, mill, and proposed cyanide plant. Chihuahua. Mexico.

History of the Native-Silver Mines of Batopilas: W. M. Brodie. *M. World*, XXX., 1909, 1105, 1201. Interesting account of the history of this ancient mining district in S.W. Chihuahua. Mining and methods of extraction.

Calabacillas Gold Mine: C. W. Geddes. *M. and S. P.*, 98, 1909, 689. Chihuahua, Mexico. Twenty stamp mill. Simple cyanide plant.

Cyanidation of Parral Silver Ores: H. T. Willis. *M. and S. P.*, 98, 1909, 488. List of cyaniding plants in Mexico with capacity.

Parral ores. Cost of treatment. Milling costs at various plants in Mexico, Australia and elsewhere.

Cyaniding Silver Ore in Honduras: G. E. Driscoll. *M. and S. P.*, 98, 1909, 388. The New York and Honduras Rosario M. Co., at San Juancito has changed over from pan amalgamation and concentration to an all-slime and filter-press cyanide process. Sodium cyanide better han potassium cyanide.

Cyanidation at Mercur, Utah: L. A. Palmer. *M. and S. P.*, 98, 1909, 616. Rolls. 3 Jackling, 1 Brown, and 1 Holthoff roasters, 70 tons each. 26 rectangular steel vats 48 × 24 × 4 ft. Zinc fume precipitation.

Mines and Plants of the Pittsburg Silver Peak: H. Hanson. *M. and S. P.*, 98, 1909, 657. At Blair, Esmeralda Co., Nevada. 100 stamp mill. Cyanide plant. Five 500-ton sand-leaching vats. Two Merrill sluicing slime filter presses.

Mill Conditions in the Goldfield District, Nev.: A. H. Martin. *Min. World*, XXX., 1909, 467. Discussion of plants. Description of Goldfield Con. mill, with flow sheet.

The Goldfield Consolidated Sampling Mill: J. A. Church. *E. and M. J.*, 87, 1909, 311. All the ore of the mine goes through the mill. Description and illustrations of the sampler.

Mines and Mills at Tonopah, Nev.: G. E. Wolcott. *E. and M. J.*, 87, 1909, 595. Methods of mining, milling, slime treatment, concentration. Flow sheets of Belmont and of Montana-Tonopah mills. Illustrated.

The 100-Stamp Desert Mill at Millers, Nev.: A. H. Martin. *Min. World*, XXX., 1909, 771. About 13 miles west of Tonopah. Crush in cyanide through 12 mesh; 5 Huntingdon mills. Wilfleys. Blaisdell-Butters cyanide plant. Illustrations.

Milling at Grass Valley and Nevada City: G. E. Wolcott. *E. and M. J.*, 87, 1909, 439. Description of work at Empire mill. Amalgamation, concentration and cyaniding.

The Standard Consolidated Cyanide Mill: S. F. Shaw. *E. and M. J.*, 87, 487. Bodie, Cal. Crush in cyanide, amalgamated plates. Tailings to tube mill, agitation and Moore vacuum filters.

Cyaniding Black Hills "Blue Ores": B. D. O'Brien. *M. and M.*, 29, 427. Results of experiments in cyaniding refractory ores from different mines.

Improvements in the Treatment of Slime in the Vacuum Filter Process: A. W. Allen. *E. and M. J.*, 87, 1909, 1004. Diagram of filter showing connections for simultaneous displacement method of slime treatment and description; used at Palmarejo and Mexican Goldfields Co., Zapote, Mexico.

Filter Plants at Pachuca: C. G. Patterson. *M. and S. P.*, 98, 1909, 428. The Loretto plant, 2 units of 104 frames each. The Guerrero plant at Real del Monte has 98 leaves, semi-gravity system. Plants to be doubled. Figures of work given.

Cyaniding of Silver Ores: T. P. Holt. *M. and S. P.*, 98, 1909, 546. Result of research on various silver-bearing minerals with different methods of treatment.

Cyaniding of Silver Ores: D. Mosher. *M. and S. P.*, 98, 1909, 691. Notes on the chemistry. Costs of oxidizing agents. Ozone and chlorine.

Precipitation from Cyanide Solutions by Zinc Shavings and Dust: A Comparision of Results and Costs: A. J. Clark. *Jl. Chem. Met. and M. S. S. A.*, IX., 1909, 222. Tables showing results and costs, 1906 and 1908, for zinc dust and summary comparing shavings with dust.

A Few Notes on Cupelling Gold Lead Bullion: G. Melvill. *Jl. Chem. Met. and M. Soc. S. A.*, IX., 1908, 157. Composition of tests, body and breast. Method of tamping. Life. Bars average 842 fine.

Routine Assaying on a Westralian Mine: W. B. Blyth. *Jl. Chem. Met. and M. S. S. A.*, IX., 1908, 184. Sampling, furnaces, weighing and fluxing, parting and weighing, bullion assays.

Chemistry of Bromo-Cyanogen Process: S. H. Worrell. *M. and S. P.*, 98, 356. Record of some experiments to show reactions which take place. Preparation of BrCN. Work on finely precipitated gold. The reaction suggested is

$$2KCN + Au_2 + 2BrCN = 2KAu(CN)_2 + Br_2 = 2AuCN.Br.KCN.$$

Dry Chlorine Processes: F. W. Traphagen. *M. and Mines*, 29, 449. Swinburne-Ashcroft and Baker-Burwell processes described.

The Mount Morgan Metallurgical Works. G. W. Williams. *E. and M. J.*, 87, 1909, 802. Works divided into 3. The West works treat oxidized ore from the open cut. The Mundic works treat sulphide ore from the stopes above 500 ft. The copper smelter treats ore from the copper mine. Chlorination of gold ores. Copper smelted in 4 blast furnaces, 2 converter stands. Blister is refined at Port Kemble, N. S. W.

Metallurgical Treatment of Mount Morgan Ores: J. B. Wilson. *E. and M. J.*, 87, 1909, 837. Short description with illustrations.

Pan-Amalgamation: an Instructive Laboratory Experiment: Hofman and Hayward. *Bull. A. I. M. E.*, 30, 1909, 513. Description of apparatus. Effect of time of grinding, amount of salt, time of amalgamating, weight of blue vitriol. Data and curves given.

The Pearce Gold Separation Process: H. V. Pearce. *Bull. 26, A. I. M. E.*, 1909 167. Gold-copper bottoms granulated and melted with pyrite, yielding matte and bottoms carrying bulk of gold. Repeated until rich enough to refine with niter.

The Salt Lake, Utah, Government Assay Office: L. A. Palmer. *M. World*, XXX., 1909, 781. Opened Feb. 1, 1909. Three gas furnaces, 50, 500 and 1800 oz. capacity. Graphite crucibles borax flux. Very base metal oxidized by blowing air into crucible through graphite tube. Dip sample for base metal. Drillings or chips for other metal.

IRON AND STEEL.

Iron and Steel Industry in 1908: F. Hobart. *E. and M. J.*, 87, 74. Gives amount of ore. Pig iron, imports and exports, for 1907 and 1908.

Open-Pit Iron Mining: J. F. Wolff. *M. and M.*, 29, 291, 343. Method of mining on the Mesabi range with photographs of the Agnew, Mahoning and Hull-Rust mines. Limits of Bessemer and Non-Bessemer.

Iron Operations in the Chattanooga District: E. Higgins. *E. and M. J.*, 87, 1. Roane Iron Co. Ores. 2 blast furnaces 17 × 80 ft. at Rockwood. Dayton Coal and Iron Co. Furnaces at Dayton, two furnaces 17½ × 75 ft. Citico Furnace Co., one stack at Chattanooga. 17 × 69 ft. Illustrations of furnace plant and coke ovens.

The Lorraine Deposits of Oölitic Iron Ore: T. Callot. *E. and M. J.*, 87, 1909, 1221. Gives ore reserves. Output, description of deposits, with sketch map of the field.

Some Criticisms of British and American Methods of Iron and Steel Production: E. G. L. Roberts. *I. and S. Times*, I., 1909, 285. Ore and blast-furnaces. Bessemer steel production. Open hearth. Dimensions of furnaces. Rolling mills.

Recent Progress in Our Iron and Steel Industries: I. and S. Times, I., 1909, 306. Gas firing. Open hearth furnaces. Dry blast for blast furnaces. Electric furnaces.

Cost of Pig Iron Made from Lake Superior Ores: J. R. Finlay. *E. and M. J.*, 87, 1909, 739. Map showing transport of ore. Discussion of costs of mining and smelting. Total $12.08 Pittsburgh. Gary's figure $12.11 given in detail.

Orehandling Bridge at Duquesne Steel Works: E. and M. J., 87, 1909, 943. Bridge spans a yard 1,800 ft. long, 230 ft. span between trucks and extends 65 feet at each end. Westinghouse motors. 10-ton Hulett excavating bucket. Photographs.

Heyl and Patterson Ore Bridge: Iron Age, 83, 1909, 476. Equipment at Duquesne, illustrated.

Ore Distribution at the Base of the Blast Furnace: Iron Age, 83, 1909, 1190. Neeland apparatus at Duquesne. Diehl improvement, ore bucket rotates while being filled.

Stock Distribution for Blast Furnaces: J. E. Johnson. *Iron Age*, 83, 1909, 1488. Description of revolving charging apparatus with unsymmetrical dumping of main bell and partial rotation while closing.

Charcoal and Coke as Blast Furnace Fuels: R. H. Sweetzer. *Bull.* 21, *A. I. M. E.*, 1908, 303. Work of comparison during 1905 at Algoma Steel Co., Sault Ste. Marie, Ontario. For 4 months one furnace was run on charcoal, the other on coke.

Gayley Dry Blast at Warwick Furnaces: E. B. Cook. *Bull.* 24, *A. I. M. E.*, 1908, 917. Description of plant. Illustrations. Account of work done.

Utilization of Blast-Furnace Slag: C. de Schwarz. *J. I. and S. I.*, I., 1908, 137. Discussion of various methods of brick and cement making.

The Methods of the U. S. Steel Corporation for Commercial Sampling and Analysis of Iron Ores: J. M. Camp. *Electro. and Met. Ind.*, VII., 1909, 65. Car sampling. Cargo sampling. Determination of iron silica, phosphorus, alumina, manganese, lime, magnesia, sulphur and moisture.

Westinghouse Gas Engines at Gary: Iron Age, 83, 1909, 713. Description of gas-driven blowing engines. Plans and illustrations.

Utilizing Blast Furnace Gases at Gary: E. and M. J., 87, 20. A 500 ton coke furnace gives off in 24 hrs. 2,800,000 cu. ft. gas. 30 per cent. used in stoves, 7.5 per cent. under boilers, 5 per cent. lost in cleaning, etc., leaving 57.5 per cent. for power of which 12.5 per cent. is for blowing engines or 45 per cent. for operating works. Cleaning. Power station. Blowing engines.

The Greatest Steel Plant in the World, I.: Iron Age, 83, 1909, 1. The Gary works of the Indiana Steel Co. Map showing location. Ore docks and yards, 16 blast furnaces and stoves. Pig-casting machines. Plan of works given.

II.: p. 373. Power plant. Allis-Chalmers twin tandem gas engines.

III.: p. 1035. Six open-hearth buildings, 14 furnaces each. 300-ton mixer. Morgan producers. The rail mill.

IV.: p. 1403. Shops, stoves, foundry, etc., with illustrations and plans of the various departments.

The Gary Pig Casting Plant: Iron Age, 83, 1909, 139. Plan of pig-casting plant. Description and illustration of Heyl and Patterson machines.

Barrow Hematite Steel Works: A. While. *I. and S. Times*, I., 1909, 198. Description of gas engine blowing plant.

The Harmet Process of Ingot Compression: J. F. Springer. *Iron Age*, 83, 1908, 2002. Description of Harmet ingot compressor, top and bottom plungers. Results obtained. Photomicrographs of steel, etc.

Alliance Open-Hearth Charging Machines: Iron Age, 83, 1909, 633. Description of the two machines used at the Pittsburgh Steel Co.'s plant at Monessen, Pa.

The Small Bessemer Converter: P. Eyermann. *Iron Age*, 83, 1909, 1998. Illustrated article on combined converter and cupola plant. Converter 3,500 lbs. capacity.

Air Furnace Construction for Malleable Castings: W. H. Kane. *Iron Age*, 83, 1909, 1842. Description with detailed drawings of 15-ton reverberatory.

A Reliable Rail and How to Make it: J. E. York. *Bull. 29, A. I. M. E.*, 1909, 455. Description of York transverse mill for solidifying ingots and York universal mill for rolling rails.

Rolled Manganese Steel Rails: Iron Age, 83, 1909, 1261. Manard steel of Pennsylvania Steel Co. now being rolled into rails. Description of a machine for testing rail wear in full sized section.

Manganese Steel: Schneider and Co. *Rev. de Met.*, 6, 1909, 551. Uses and properties, with numerous illustrations showing its application.

The Use of Titanium in Steel for Rails, Carwheels, etc.: C. V. Slocum. *Electro. and Met. Ind.*, VII., 1909, 128. Ferrotitanium used in making Bessemer steel rails at several plants. Used in O. H. steel, crucible steel and for chilled castings.

Plant used in the Manufacture of Tubes: W. H. A. Robertson. *Met. Ind.*, 15, 1909, 17–66. Mannesman, punching, Elmore, centrifugal processes, chain driven draw benches. Hydraulic benches.

Presses and Dies: Stamper. *Met. Ind.*, 15, 1905, 57. Drawing Dies.

The Manufacture of Seamless Tubes from Plates: Iron Age, 83, 1909, 728. National Tube Co.'s Shelby seamless tubes. Cupping of plate. Hot-drawing bench.

Manufacture of Tin Plates and Terne Plates: W. G. Gray. *Iron Age*, 83, 1909, 1598. The history of the trade. Statistics.

Rockwell Internally Fired Helical Furnace: C. M. Ripley. *Iron Age*, 83, 1909, 638. For small sized material such as coin blanks, steel balls, screws, etc. Tubular furnace, revolving. Photographs and section.

Arc-Welding: C. B. Auel. *Iron Age*, 83, 1909, 1992. Describes electric welding by Thomson, Zerener, LaGrange-Hoho and the Bernardos methods.

Rusting of Iron: Heyn and Bauer. *Electro. and Met. Ind.*, VII., 1909, 33. Abstract of work given from Stahl und Eisen, Oct. 28, 1908. Rôle of CO_2. Iron rusts when CO_2 is absent. Rate of attack of various kinds of iron, details of analyses, etc.

The Rusting of Iron: J. N. Friend. *J. I. and S. I.*, II., 1908, 5. Description of experiments, the results of which show electrolytic theory untenable. The corrosive action of rust lies in its hygroscopic nature. Water containing carbonic acid condenses and further corrodes the metal.

Electro Metallurgy of Iron and Steel: Electro. and Met. Ind., VII., 1909, 250. Abstract of papers at Niagara Falls meeting of American Electrochemical Society. Electric Furnace Pig Iron in Sweden, in California. Noble Steel Co., Cal. Stassano Steel Furnace, Keller, Girod and Heroult steel processes. Silico-vanadium. Vanadium. Low Carbon Ferro-Alloys. Electric Furnaces, etc.

Present State of Manufacture of Steel in the Electric Furnace: Clausel de Coussergues. *Rev. de Met.*, 6, 1909, 589. A discussion of the different furnaces and their work. Many excellent illustrations showing the Roechling, Heroult, Girod, Stassano and others.

Small Experimental Heroult Furnace: C. A. Hansen. *Electro. and Met. Ind.*, VII., 1909, 206. Illustrated description of a simple furnace, consumption of electrodes, power consumption, slags, linings, etc.

The Heroult Electrical Furnace: R. Turnbull. *Iron Age*, 83, 1909, 1498. Historical. Main features of the furnace and its application.

A Study of Electric Furnaces: C. A. Keller. *Iron Age*, 83, 1909, 1753. Description with illustrations of the Keller furnace at Unieux.

New Resistance and Induction Furnace: A. Gradenwitz. *E. and M. J.*, 87, 1909, 364. A description of the Röchling-Rodenhauser furnace. Photograph.

The Largest Electric Steel Works: J. W. Richards. *Electro. and Met. Ind.*, VII., 9, 1909. Description of the Girod works at Ugine, Savoy. Two 2-ton furnaces, two 10-ton. Output 50 tons a day.

The Stassano Electric Furnace: F. C. Perkins. *M. and M.*, 29, 277. New plant at Turin, with two 100-H.P., one 200-H.P. and two 1,000-H.P. furnaces. Description of the furnace.

Smelting Iron Ore in the Electric Furnace, in Comparison with Blast Furnace Practice: J. Härdén. *Electro. and Met. Ind.*, VII., 1909, 16. Blast furnace, $6.84 per ton of iron. Electric furnace, $9.70 per ton. List of literature in electric smelting given.

Deoxidation and Desulphurization in Electric Steel Furnaces: R. Amberg. *Electro. and Met. Ind.*, VII., 115. High temperature the chief advantage over gas furnaces.

Lead, Zinc, Tin.

Modern Silver-Lead Smelting at Laurium, Greece: H. F. Collins. *E. and M. J.*, 87, 1909, 881. Table of ores; 12 old Spanish blast furnaces replaced by one standard 250–300-ton furnace; 156 × 44 in., 20 ft. 4 in. column. New method of continuous slag flow with controlling plug, forehearth, slag granulation.

Notes on Various Applications of the Elmore Vacuum Process: A. S. Elmore. *E. and M. J.*, 87, 1909, 1275. Methods at Dalcoath, Ramsley and Dolgelley mines; the Zinc Corporation, Broken Hill; Edmundian Cu mine, Apica; Garpensburg mine, Sweden; Fraag mine, Norway; Hadeland mine, Norway; Telemarken mine, Sulitelma mine, Norway, and Saxberget mine, Sweden.

Elmore Vacuum Plant: M. and S. P., 98, 1909, 391. Zinc corporation's works at Broken Hill. Zinc tailings. Zn 20 per cent., Pb 5.75 per cent., Ag 8 oz. Rhodonite and garnet gangue. Grinding pans to 30 mesh; 16 units of Elmore plant. Deoiling ovens. Wilfleys. Two products. Zinc concentrate. Zn 46.5 per cent., Pb 7.25 per cent., Ag 16 oz. Lead concentrate, Pb 58 per cent., Zn 15 per cent., Ag 39 oz.

El Tigre Mine: R. L. Herrick. *M. and M.*, 29, 483. Montezuma, Sonora. Gives an account of mine and milling. Lead-zinc ore over 300 oz. Ag and 4 oz. Au.

Bessemerizing of Hardhead: Levy and Ewen. *Bull. 56*, 1909, *I. M. and Met.* Hardhead runs Fe 50, Sn 25, As 25. Freezes at 806° C. Bessemerizing converts hardheads into highly ferruginous slag and a fume of arsenic oxide with some tin oxide. Nickel and cobalt gradually concentrate in the button. Discussion. *Bull. 57, p. 23.*

The Detinning Industry: K. Goldschmidt. *Electro. and Met. Ind.*, VII., 1909, 79. From *Stahl und Eisen*, Dec. 30, 1908. Takes up electrolytic detinning, chlorine detinning, detinning of old cans.

The Rare Metals: C. Baskerville. *E. and M. J.*, 87, 1909, 10. VI., Titanium minerals, uses. 87, 1909, 203. VII., Tungsten. 87, 257. VIII., Uranium. 87, 1909, 518. IX., Vanadium. 87, 548. X., Zirconium. See A. H. Hale, 87, 813.

Vanadium-Deposits of Peru: D. F. Hewett. *Bull. 27, A. I. M. E.*, 1909, 291. Description of the Yauli and Quisque deposits. References on vanadium, Moissan, *Chimie Minérale*, III., 1905, Nicolardot, Le Vanadium (1905), etc.

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Coal Mining in Central West Virginia: F. W. Parsons, *E. and M. J.*, 87, 1909, 1284. Coalton plant has 200 beehive ovens, 3.8 tons each. Photograph showing ovens.

The Largest Coke-oven Gas Engine Plant: J. B. Van Brussel. *E. and M. J.*, 87, 1909, 1189. Gas-engine power station at Anna II mine of the Eschweiler Mining Co., at Alsdorf near Aix-la-Chapelle, Germany, uses coke-oven gas. Description with illustrations of engines.

The Use of Producer Gas in Chemical and Metallurgical Industries: O. Nagel. *Electro. and Met. Ind.*, VII., 1909, 29, 158. Discusses design of gas-fired furnaces such as Siemens crucible, chloridizing roasting, zinc distillation and other furnaces.

The Combustion of Producer Gas: O. Nagel. *Electro. and Met. Ind.*, VII., 1909, 202. Discusses mixing devices for gas and air.

Coal Briquetting: C. T. Malcomson. *M. and M.*, 29, 339. Description of Renfrew Briquet Press, and Hartshorne plant, Oklahoma.

METALLOGRAPHY — ALLOYS.

Piping and Segregation in Steel Ingots: Discussion. *Bull. 21, A. I. M. E.*, 1908, 395.

Work of Testing Dept. of the Watertown Arsenal in Relation to the Metallurgy of Steel: J. E. Havard. *Bull. 20, A. I. M. E.*, 1908, 151. Discussion on rails, tires, etc., *Bull. 21, A. I. M. E.*, 1908, 427.

A New Fatigue Test for Iron and Steel: T. E. Stanton. *J. I. and S. Inst.*, I., 1908, 54. A machine consisting of three hardened steel rollers between which is placed a ring of the metal to be tested. Upper roller weighted and revolved. The ring to be tested revolves in a state of strain. Fracture finally occurs.

The Landgraf-Turner Alternating Impact Machine: I. and S. Times, I., 1909, 340. Test bar firmly clamped in vice. Rocker arm with two tool steel hammer dies deflects the test-bar after impact. Veeder counter.

A New Polishing Machine for Metallographic Work: J. Aston. *Electro. and Met. Ind.*, VII., 15, 1909. Horizontal machine with interchangeable discs held in place by magnetic clutch.

A Very Simple and Inexpensive Microscope: G. Revol. *Rev. de Met.*, 6, 1909, 442. Illustrated description of horizontal microscope with specimen clamped by two springs so as to be perpendicular to optical axis.

New Metallographic Microscope by Reichert: O. Heimstädt. *Metallurgie*, 6, 1909, 58. Like the Le Chatelier form the objective points upward and specimen is face downward on the stage. Camera horizontal. Illumination by thin glass plate (Beck) instead of prism. Instrument very solid.

Note on a Workshop Microscope: J. E. Stead. *J. I. and S. I.*, III., 1908, 22. Stand consists of a disc supported by 3 legs with hard steel points. Focus by drawing tube. Illumination by storage battery. For low power work.

The Pyrometric Installation in Royal Gun and Carriage Factories, Woolwich: J. W. Lambert. *J. I. and S. I.*, I., 1908, 109. Le Chatelier thermo-couples. Roberts-Austen recorders, Pitkin and Co. Method of getting surface temperatures. Installation for differential cooling curves.

On the Production of Electrolytic Iron, Composition and Thermal Properties: A. Müller. *Metallurgie*, 6, 1909, 145. Practical method of production. Vacuum-furnace and its construction (1700° C.). Freezing point 1505° C., critical 1206° C., Ar_3 894, Ac_3 917, Ar_2 763, Ac_2 770° C.

The Freezing Point of Iron: H. C. H. Carpenter. *J. I. and S. I.*, III., 1908, 290. Mean value 1505° C., by thermo-electric method, which corresponds to 1519° C. on the optical scale

On the Melting of Iron Oxide: E. J. Kohlmeyer. *Metallurgie*, 6, 1909, 323. Apparatus and method. 1565–1527° C. Critical points 1350–1250 and 1035° C.

Microstructure of Copper Examined with a New Etching Reagent: R. B. Abbott. *E. and M. J.*, 87, 1909, 1040. Use a 10 per cent. solution of ammonium persulphate, boiling. Time 1 to 10 seconds.

On the Formation of Alloys by Pressure and the Reaction of Metals in the Solid: G. Masing. *Zeits. an. Chem.*, 62, 1909, 265. Pressure merely forms a mechanical mixture, not compounds or solid solutions.

Binary Alloys: K. Bornemann. *Metullurgie*, 6, 1909, 336, 296, 326. (1) The alkali metals. (2) Copper alloys. (3) Silver alloys.

The Alloys of Antimony: Portevin. *Rev. de Met.*, 6, 1909, 241. Further translation of work upon Zeits. an. Chem. Alloys of Sb with Bi, Ca, Cd, Co, Cr, Fe, Na, Si, Sn, Tl and Zn.

Platinum-Antimony Alloys: Friedrich and Leroux. *Metallurgie*, VI., 1909, 1. The curve shows max. at $PtSb_2$, 1226° C. Up to this point $PtSb_2$ found in a ground mass of Sb. Minimum at 700° C., eutectic of Pt and PtSb (?) which forms by reaction of $PtSb_2$ and melt. Change in solid — Pt_5Sb_2.

Silicon-Calcium Alloys: S. Tamaru. *Zeits. an. Chem.*, 62, 1909, 81. The curve shows Ca + $CaSi_2$ between 0 and 59 per cent. Si and Si +

$CaSi_2$ beyond. Reaction of Si with liquid 35 per cent. Si = $CaSi_2$ at 995° C. Constant temp. up to 59 per cent. Si is 803° C., the freezing point of Ca.

Silicon-Calcium-Alminium Alloy: Electro. and Met. Ind. VII., 1909, 131. Si 47–57 per cent., Ca 15–25 per cent., Al 2½–6½ per cent. Energetic deoxidizer and secures better desulphurization.

Silicon-Magnesium Alloys: Lebeau and Bossuet. *Rev. de Met.*, 6, 1909, 233. The compound $SiMg_2$ found.

Sulphur-Arsenic System: W. P. A. Jonker, *Zeits. an. Chem.*, 62, 1909, 89. Freezing-point and boiling-point curves given. As_2S_2 is dissociated, As_2S_3 is not.

Laboratory Methods of Making Alloys of Iron and Vanadium: W. L. Morrison. *E. and M. J.*, 87, 1909, 1035. Alloys may be made by Goldschmidt method or in the electric furnace of resistance type carrying 4 one-lb. magnesia crucibles. Use puddled iron and ferrovanadium.

The Iron Sulphur Alloys: Ziegler. *Rev. de Met.*, 6, 1909, 459. In commercial sulphide of iron a composite eutectic is found built up of the eutectic of FeS and Fe and that of FeO and Fe. Sulphur in steel.

Constitution of Iron and Phosphorus Compounds: B. Saklatwalla. *J. I. and S. I.*, II., 1908, 93. Thermal and microscopic examination. Iron holds up to 1.7 per cent. P in solution. Fe_3P and Fe (1.7 per cent. P) form a eutectic at 10.2 per cent. P and 1005° C. Fe_3P (1120° C.) and Fe_2P (1275° C.) form a eutectic at 16.2 per cent. P and 960° C.

Iron, Carbon and Sulphur: D. M. Levy. *J. I. and S. I.*, II., 1908, 33. In cast iron free from Si and Mn. Sulphur up to 0.8 per cent. exists in FeS (m.p. over 1180° C.). (In steels FeS exists as eutectic, m.p. 970° C.) Sulphur lowers m.p. of cast iron, etc. Triple austenite, cementite, sulphide eutectic.

The Alloys of Iron, Carbon and Phosphorus: J. E. Stead. *I. and S. Times*, I., 1909, 301. Triple eutectic freezes at 950° C., P = 6.7, C = 2 per cent. The freezing of Cleveland pig irons. Behavior of C and P in steel. Effect of heat treatment.

The Carbon-Iron Diagram: H. M. Howe. *Metallurgie*, 6, 1909, 65. *B. A. I. M. E.*, 1908, 22, 461. Discussion of evidence of Roozeboom diagram and that of the double diagram.

The Nature of Cast Irons: G. B. Upton. *J. Phys. Chem.*, XIII., 1909, 388. Continuation of discussion of evidence for system made up of Fe_6C, Fe_3C and Fe_2C See: *The Iron-Carbon Equilibrium: J. Phys. Chem.*, 12, 507.

Influence of Manganese on the Iron Carbon System: F. Wüst. *Metallurgie*, 6, 1909, 3. A series of alloys with carbon, 4–7 per cent. Mn up to 80 per cent., were made. Cooling curves and micrographs taken. Up to 13 per cent. Mn the freezing point of the cast iron is lowered to 1120° C., then increases to 1258° C., with 80.45 per cent. Mn, 6.9 per cent. C. The difference between Ac_1 and Ar_1 increases with the Mn. The amount of carbon in the eutectic decreases to 4.05 per cent. with

15 per cent. Mn. With increase in manganese pearlite is replaced by troostite and the solid solution of carbon in gamma iron.

The Heat Treatment of Steel: A. Campion. *I. and S. Times*, I., 1909, 157. Curves showing relation between drop-test and temperature of treatment. Photomicrographs.

A New Form of Pearlite: C. A. F. Benedicks. *I. and S. Times*, I., 1909, 135. Description of "bead" pearlite, a transition between the laminated and granular form.

Hardness of the Constituents of Iron and Steel: H. C. Boynton. *J. I. and S. I.*, II., 1908, 133. Taking Ferrite as 1. Pearlite = 4.3. Sorbite 5.2–52. Troostite 88. Austenite 104. Martensite 239. Cementite 271. By Jaggar's Micro-sclerometer. Series of tests made on acid O.H. wire C = 0.77 to find effect of work.

On the Hardening and Tempering of Iron and Steel: E. Maurer. *Metallurgie*, 6, 1909, 33. Research on density, hardness, conductivity and magnetism of steel after hardening at different temperatures and after tempering the same at various temperatures. Metallography.

The Improvement of High Speed Tool Steel: H. C. H. Carpenter. *I. and S. Times*, I., 1909, 139. Composition and cutting speed of four types, Jessop Carbon, Mushet Self Hardening, Original Taylor White and modern high-speed steel. Improvements in manufacture and treatment.

Function of Chromium and Tungsten in High-Speed Tool Steel: C. A. Edwards. *J. I. and S. I.*, II., 1908, 104. Case hardening nose of tool increased cutting properties. Chromium forms a double carbide with tungsten which remains in solution when very slowly cooled. No critical points below 900° C. when cooled from 1320° C.

Cooling Power of Liquids on Quenching Velocities: C. Benedicks. *J. I. and S. Inst.*, II., 1908, 153. Part I. deals with the behavior of different liquids, in cooling a heated body. Latent heat of vapor the main factor. Specific heat and conductivity can be neglected. A liquid must have (1) a high latent heat of vapor, (2) so low a temperature that the vapor bubbles formed at the surface of the metal may be easily condensed in the surrounding liquid. Part II., registration of time of cooling from 700° to 100° C. on quenching. III. deals with troostite, which depends on the cooling velocity; is a solid colloid solution. IV. deals with austenite, pressure necessary for its formation or preservation.

On the Nature of Copper Mattes: Baykoff and Troutneff. *Rev. de Met.*, 6, 1909, 519. Work of Röntgen and Hofman discussed. Curve found shows a minimum of 957° C. 45 per cent. Cu_2S. The system forms a series of solid solutions which however transform in the solid state.

Constitution of Copper-Iron and Copper-Lead-Iron Mattes: Fulton and Goodner. *Bull. 24, A. I. M. E.*, 1908, 959. Discusses systems FeS — Fe, Cu_2S — Cu, PbS — Pb. Then Cu_2S — FeS, PbS — FeS, Cu_2S — PbS. Examination of commercial mattes.

The Problem of Bearing Metals: S. K. Patteson. *Electro. and Met. Ind.*, VII., 1909, 21. Fifty million dollars worth in actual use. Analyses of 18 bearing metals given. See *Metals in Bearings — Anti-frictional Properties of Lead: Metal Ind.*, 15, 1909, 20.

Government Specifications for Manganese Bronze: J. L. Jones. *Met. Ind.*, 15, 1909, 1. Criticism of government specifications. One very funny example.

Manganese Bronze: Met. Ind., 15, 1909, 173, 175. Analyses. Physical properties.

Monel Metal: D. H. Browne. *Electro. and Met. Ind.*, VII., 1909, 114. Alloy of 68 to 72 per cent. Ni. Iron 0.5 to 1.5 per cent.; rest copper. Melts at 1350° C. Rolled between 900 and 1200° C. Tensile strength, etc., are given.

Monel Metal — Recent Progress: H. E. Flewellen. *Met. Ind.*, 15, 1909, 14. Gives physical properties compared with other material. Uses.

GENERAL.

A Model Chemical and Metallurgical Laboratory and Testing Plant: Electro. and Met. Ind., VII., 1909, 41. Description of plant of C. T. Hennig. Stamp mill, concentrating, cyaniding, etc. Rolls, crusher, etc. Reverberatory, blast furnace, power hammer. Six electric furnaces for smelting refractory metals, etc.

The Hammond Mining and Metallurgical Laboratory of the Sheffield Scientific School, Yale University: L. D. Huntoon. *Bull. 27, A. I. M. E.*, 1909, 229. Ore testing lab. Assaying and metallurgical lab., milling lab., etc., and their equipment, use, floor areas, etc.

The Metallurgical and Chemical Laboratories in the National Physical Laboratory: W. Rosenhain. *J. I. and S. I.*, I., 1908, 87. Two divisions, metallurgical research work, and metallurgical chemistry. Description of apparatus.

Behavior of Calcium Sulphate at Elevated Temperatures with Some Fluxes: H. O. Hofman and W. Mostowitsch. *Bull. 25, A. I. M. E.*, 1909, 51. Hydrous calcium sulphate loses its water at about 900° C. Anhydrous remains unchanged up to 1200° C., then begins to give off SO_2 and O. Fuses at 1360° C. SiO_2 decomposes it, beginning at 1000° C., end at 1250° C. Fe_2O_3 decomposes it at 1100° C., end at 1250° C. Calcium ferrite, CaO, Fe_2O_3, fuses at 1250° C. Pure lead oxide has no decomposing effect on calcium sulphate.

Reduction of Refractory Oxides, Production of Ferro-Alloys and Formation of Carbides: Electro. and Met. Ind., VII., 1909, 119. Abstract of electric furnace research at University of Manchester. (*Trans. Chem. Soc.*, 1908, Vol. 93, pp. 1484, 1496, 327 and 2101.) Carbon begins to reduce Cr at 1185° C., Mn at 1105° C., uranium at 1490° C., Si at 1460° C., Zr at 1400° C. and thorium at 1600° C. The effect of presence of other metals in the reduction of refractory oxides by means of carbon was investigated. Formation of carbides. Silicon and carbon unite at 1250–1300° C. in vacuo. Al unites with carbon at its melting point (650° C.), Al_4C_3. Iron unites with carbon at about 700° C. Mg_3C unstable.

Thermal Data in Roasting: K. Friedrich. *Metallurgie*, 6, 1909, 169. Experiments in roasting various sulphides in air and in oxygen, formation of SO_3, etc.

Silundum; a New Product of the Electric Furnace: F. Bölling. *Electro. and Met. Ind.*, VII., 1909, 24. Silundum a form of silicon carbide is hard, resists temperatures up to 1600° C. and does not oxidize. Conductor of electricity with a resistance several times that of carbon. Uses for cooking and heating apparatus.

Cupellation Experiments: the Thermal Properties of Cupels: C. O. Bannister and W. N. Stanley. *Bull. 58*, 1909, *I. M. and Met.* Differences in thermal properties of bone-ash and patent cupels worked out.

The Minting of Silver Coins: H. D. Coleman. *Met. Ind.*, 15, 1909, 11–68. Crucibles and melting. Breaking down the ingot and rolling. Punching, stamping and milling.

ABSTRACTS OF RECENT MINING DECISIONS.*

LOCATION OF CLAIMS.

Location of Mining Claim — Discovery.

To constitute a valid location, there must be such a discovery of mineral as that an ordinarily prudent man, not necessarily a miner, would be justified in expending his time and money thereon, in the development of the property. While mere possibility that ground claimed contains gold, or that there are mere indications of the existence of minerals in the ground, is not sufficient to justify a prudent person in expending money and work in exploration of it, yet where the evidence shows the actual existence of gold in the claim, the locator is entitled to strengthen the proof upon any of the elements which enter into what is comprehended by discovery. He may supplement the showing that mineral actually did exist, by proving, as a ground of justification, for the expenditure of time and money, that the adjacent ground in the same gulch is rich in the same material, or that adjacent claims were developed into paying mines after development upon similar showings of mineral, or that geological conditions are so similar that, from the character of the mineral discovered, it is reasonable to expect to find mineral in valuable quantities in the exploration of the alleged claim. But there must be an actual discovery of mineral within the limits of the claim before a valid location can be established.

Cascaden *v.* Bortolis, 162 Federal 267, May, 1908.

MINING LEASES.

Mines — Conveyance and Lease of Minerals.

A clear distinction exists between a grant of a right for a term of years to take mineral from certain premises, coupled with the right to ingress and egress, and direct sale of such mineral in place; the latter amounts to conveyance of an interest in the land itself, the former does not and is not taxable.

Board of Supervisors Hancock County *v.* Imperial Naval Stores (Miss.), 47 Southern 177, June, 1908.

Oil Lease — Construction.

An ordinary lease, giving the lessee the exclusive right to explore for and sell oil from the land on payment of a stipulated royalty, does not give to the lessee the title to the oil in place.

Backer *v.* Penn Lubricating Co., 162 Federal 627, June, 1908.

* Prepared for the School of Mines Quarterly by J. W. Thompson, Attorney-at-Law, Indianapolis, Indiana.

OIL LEASE — NATURE AND CONSTRUCTION.

Oil leases stand on a different basis from ordinary leasehold agreements, for the reason that the work which is to be done is ordinarily of an experimental and speculative nature, and if oil is not found no estate vests in the lessee. The rule that forfeiture or abandonment is not looked upon with favor is not applied to an oil lease.

Conklin *v.* Krandusky, (N. Y.) 112 New York Supplement 13, July, 1908.

OIL LEASE — ABANDONMENT.

Under an oil lease for 15 years and as long as oil should be found in paying quantities, the lessee drilled a well but found no gas; he afterwards removed all the drilling machinery and tools, except the casing in the well, and did no other drilling for more than ten years, this was held to be an abandonment of the lease.

Conklin *v.* Krandusky, (N. Y.) 112 New York Supplement 13, July, 1908.

OIL AND GAS LEASE — CONSTRUCTION AND EFFECT.

An ordinary oil and gas lease conveys no interest in the real estate; nor does it convey any present title to the oil or gas which may be in the leased premises. Its effect is to grant the privilege of exploring for oil and gas, and gives the right to sever the same if found.

Beardsley *v.* Kansas Natural Gas Co., (Kan.) 96 Pacific 859, July, 1908.

OIL AND GAS LEASE — DAMAGES FOR BREACH.

It is competent for the parties to fix the amount of damages for any breach of an agreement in an oil and gas lease binding the lessee to drill a well on the property within a specified time; and they may provide that in case of the failure of the lessee to drill such wells he shall pay a stated sum as liquidated damages.

Blodget *v.* Columbia Live Stock Co., 164 Federal 305, October, 1908.

ASSESSMENT WORK.

MINING CLAIM — FAILURE OF CO-OWNER TO CONTRIBUTE.

If one of several co-owners fails to contribute his proportion of the required work or make the necessary improvements, the other co-owners who have done the required work may give such delinquent notice and after the stated time if such delinquent fails or refuses to contribute his proportion of the expenditures, his interest in the claim shall become the property of the co-owners. But the question of the performance of assessment work sufficient to prevent the forfeiture of the interest of a co-owner is one of fact for the jury to determine.

Knickerbocker *v.* Halla, 162 Federal 318, May, 1908.

MINING CLAIM OWNED BY CORPORATION — ASSESSMENT WORK BY STOCKHOLDERS.

Stockholders of a corporation have such a beneficial interest in the corporate property that mining work done by them on unpatented

claims of the corporation must be counted as representative work; and if the work so done by them is sufficient in amount and performed within the time, it will prevent a forfeiture of the claim.

Wailes *v.* Davies, 164 Federal 397, October, 1908.

LIABILITY OF INJURY TO MINER.

Injury to Miner — Contributory Negligence.

A coal miner, killed by the falling of the roof of the mine where he was working, was not guilty of contributory negligence in working under the roof when he knew of the defect in the roof, and voluntarily went under it, unless it was shown that he knew the defective roof was dangerous; it was the owner's duty to prop the roof and make it safe. But under such circumstances there could be no recovery where the mine boss warned him of the danger and instructed him not to work under it.

Mascot Coal Co. *v.* Garrett, (Ala.) 47 Southern 149, June, 1908.

Injury to Workmen in Quarry — Contributory Negligence.

A workman injured in a quarry by rock falling from a wall cannot recover on the ground of negligence of the boss who sent him to shovel loose rock, or "sprawl," near where there was loose work in the wall which was likely to fall, and which he could have discovered by the exercise of diligence.

Alabama Consolidated Coal & Iron Co. *v.* Hammond, (Ala.) 47 Southern 248, June, 1908.

Injury to Miner — Incompetent Engineer.

Under a statute providing that only competent and trustworthy engineers should operate the cages and hoisting devices in coal mines a coal company was liable to a miner injured through the negligence of one operating a cage who was not a competent and trustworthy engineer.

Capelling *v.* Saginaw Coal Co., (Mich.) 117 Northwestern 182, June, 1908.

Dangerous Condition of Mine — Duty of Owner to Keep it Reasonably Safe.

The law as well as the federal statutes impose upon an owner of a mine the duty of exercising reasonable care to see that the mine is in a reasonably safe condition for miners to work therein. The law does not impose upon the miner the duty of exercising care and prudence to discover the condition of the mine before beginning work. But if the mine is in such a defective or dangerous condition which is so obvious to the eye of the miner at the time and place as to make it apparently dangerous to work there, and he voluntarily proceeds to work at such place and under such circumstancs, without complaint, he assumes the risk and cannot recover in case of injury.

Bolen-Darnall Coal Co. *v.* Williams, 164 Federal 665, October, 1908.

COAL LANDS.

MINING COAL — CONSTRUCTION OF LEASE.

A coal lease defined "pea" coal "to be coal which passes with the dirt through a screen of three quarters of an inch mesh." Under such lease the lessee could not avoid payment or royalities on coal known as "buckwheat," "rice," and "barley" coal, although all of these pass through a screen of three quarters of an inch mesh.

Glick *v.* Lehigh Valley Coal Co., (Pa.) 70 Atlantic 910, May, 1908.

TITLE TO MINERALS — SEVERANCE FROM OWNERSHIP OF SURFACE.

The general presumption is that the possessor of the surface also has possession of the subsoil. But when, by conveyance or reservation, a separation has been made of the ownership of the surface of the land from that of the underground minerals, the owner of the former can acquire no title to the latter by his exclusive and continued enjoyment of the surface; nor does the owner of the minerals lose his right or possession by any length of nonusage. To lose such right he must be disseized, and there can be no disseizure by an act which does not actually take the minerals out of his possession.

Yellow Poplar Lumber Co. *v.* Thompson, (Va.) 62 Southeastern 358, September, 1908.

TITLE TO MINERALS — ADVERSE POSSESSION.

Adverse possession of the surface of lands containing minerals does not necessarily include possession of such minerals, where the title to the minerals has been severed by deed from that of the surface.

Yellow Poplar Lumber Co. *v.* Thompson, (Va.) 62 Southeastern 358, September, 1908.

QUIETING TITLE TO MINERALS — LACHES.

The purchaser of minerals from the owner of the surface immediately caused his title to be placed on the land books of the county for taxation and continuously thereafter for more than twenty-one years, paid taxes thereon; and during this entire period he occasionally visited the land for the purpose of seeing that there was no actual adverse possession, and not learning of any adverse claims he relied on the covenants of general warranty in his deed for the perfection of his title. Under such circumstances he was not guilty of laches, where he had no knowledge that the owner of the surface was claiming any interest in the minerals until within a year before the institution of the suit.

Steinman *v.* Jesse, (Va.) 62 Southeastern 275, September, 1908.

CONTRACT FOR DRILLING COAL LAND — CONSTRUCTION — RECOVERY.

A contract for drilling coal land stipulated for the payment of a certain price per foot up to a given depth if coal was not reached before that depth. It also stipulated for the payment of the same price if it was necessary to go to a greater depth. In an action to recover on a contract by the driller, the court held that the contractor's right to re-

cover was not dependent on striking coal; and especially where it appeared that payments for work done had been made as though striking coal was not a condition precedent.

Western Fuel Co. *v.* Fuller, (Ark.) 113 Southwestern 1021, November, 1908.

OPERATION OF MINES — LIABILITY FOR INJURIES TO SURFACE PROPERTY.

The owner and operator of coal mines was held liable in damages for the drying up of the wells of water of the owner and occupant of the surface lands, which resulted directly from the negligent operation of the mines. It was sufficiently shown that cracks and fissures in the surface lands, occurring at the time of the disappearance of the water in the well, were caused by the negligence of the owner of the mines in failing to properly and sufficiently timber or otherwise sufficiently support the roof of the mine.

Sloss-Sheffield Steel & Iron Co. *v.* House, (Ala.) 47 Southern 572, November, 1908.

TITLE TO COAL IN PLACE — POSSESSION — NOTICE.

In a controversy between the persons claiming to own the surface by purchase under a verbal agreement, and a coal company which purchased the coal in place, where no deeds were executed and recorded, it was held that the entry upon the land by the purchaser of the surface and clearing a small tract upon which he sowed a crop, and around which clearing he built a brush fence and afterwards built a small cabin and rented part of the land to a third person, was not sufficient to show such open, notorious and exclusive possession as would be notice of ownership to the corporation purchasing the coal. The possession and use of lands by a person other than the grantor must, in order to afford notice to others, be open, notorious and exclusive. It must be unambiguous and unequivocal and under a claim of right. And like other matters from which constructive notice is sought to be imputed, it must be of such character as will excite inquiry on the part of the prospective purchaser and lead him in the exercise of due diligence to a knowledge of the adverse rights of the person claiming the possession.

Crane's Nest Coal & Coke Co. *v.* Virginia Iron, Coal & Coke Co., (Va.) 62 Southeastern 954, November, 1908.

MISCELLANEOUS.

MINING CORPORATION — COMPENSATION OF OFFICERS.

A director of a mining corporation who held the office of secretary, was not entitled to compensation for services as such secretary, in the absence of any provision in the charter or by-laws, or a contract in advance to that effect.

Silverton Mining Co. *v.* Houghwout, (Colo.) 96 Pacific 975, July, 1908.

MINING PARTNERSHIP.

Two persons, under a lease of mining property, agreed to work the property jointly, each to bear one half the expense. Where one put in his own work and the other furnished a third person to do his share of the work, they were engaged in a joint enterprise for the purpose of carrying out the provision of the lease and were equal partners. A mining partnership exists where the several owners of a mine coöperate in working it.

Walker *v.* Bruse, (Colo.) 97 Pacific 250, July, 1908.

ACTION TO RECOVER MINES — INJUNCTION.

In an action in ejectment to recover certain mining grounds the plaintiffs were entitled, under a statute giving an injunction where another is doing or threatening to do some act in violation of the plaintiffs' rights and tending to render any judgment recovered ineffectual, to an injunction ancillary to the main action restraining the defendants from operating a mine on the ground in controversy, pending the action, on a showing that such ground was chiefly valuable for placer mining, and that the continued operation of the defendants thereon would result in irreparable injury to the plaintiffs.

Waskey *v.* McNaught, 163 Fededal 529, July, 1908.

STATUTES REGULATING MINES — CONSTRUCTIONS.

Statutes requiring coal corporations to always keep on hand near the mine, stretchers, bandages, medicines, etc., for use in case of injury to workmen, are in derogation of the common law, highly penal in character, and should be strictly construed.

Sourwine *v.* McRoy Clay Works, (Ind. App.) 85 Northeastern 782, October, 1908.

MINING PARTNERSHIP — LIABILITY OF RETIRING PARTNER.

A mining partnership, unlike an ordinary one, is not dissolved by the sale of the interest of one of the partners ; but it does not follow, from the mere continuance of the partnership, that the partner selling his interest continues liable for all of the debts of the partnership subsequently incurred. Under certain circumstances he may continue liable for a subsequently incurred indebtedness of the firm. Thus where the partnership was indebted to laborers for work done while the selling partner was still a member of the firm, and the laborers continue their work upon the property without notice of the sale of the pa tner's interest, the retiring partner will continue to be liable. The rule is that the liability of a general partner for the acts of his copartners continues, after dissolution of the partnership, in favor of persons who have had dealings with and given credit to the partnership until they receive notice of the dissolution. But a retiring partner is not liable for the wages of miners after the sale of his interest where they have notice of such sale ; neither is he liable for the wages of miners subsequently employed and who had no knowledge of his connection with the partnership.

Kelly *v.* McNamee, 164 Federal 369, October, 1908.

Sale of Mineral Lands.

A contract for the sale of mineral lands provided for the payment of a large part of the purchase price from the profits of the mines; by the terms of the agreement the purchaser was to promptly install a reduction plant for the proper treatment of the ores of the mines, and for the diligent operation of such mines to secure the means for the prompt payment of the purchase price; it was expressly stipulated that six months was sufficient time to procure and put the plant in operation; but if by using reasonable diligence it could not be completed within that time, this should be no ground for rescission or damages. It was also agreed that $60,000 of the purchase price was to be applied to the payment of liens against the property, and the vendor was to furnish a list of all liens. In an action by the vendor to rescind the contract it was held that the vendee's delay of eleven months in installing the reduction plant was not excused because the vendor's title was defective as to an undivided one forty-eighth part of the property, but which defect was not known to the vendee during the delay; and that a mere claim against the vendor was not a valid lien against the property where it was not recorded. Neither was the vendor's failure to furnish a schedule of liens an excuse for delay in building the reduction plant.

Brown *v.* Gordon-Tiger Mining & Reduction Co., (Colo.) 97 Pacific 1042, November, 1908.

SUMMER SCHOOL IN GEOLOGY.

Pottsville regrets that the Columbia University students were not permitted to remain in this vicinity for a longer stay but a week was all that was allotted them for the practical study of geology in this section of the anthracite region. In that time they covered a wide area of territory and acquired a fund of information from the open page of nature's book which will be of vast benefit to them in the further study of the earth's composite parts. They also took home with them fossils, embracing both animal and plant life, lower Schuylkill County being the richest in that respect of any part of the world. The Columbia students at all times during their stay conducted themselves as gentlemen and there was not an idle moment for them, their time from early morning until late at night being devoted to the closest application to their work. If this geological delegation is a fair representation of the makeup of the student personnel of old Columbia, it certainly is a model institution of learning. — Editorial from the *Evening Chronicle*, Pottsville, Pa., Friday, June 4, 1909.

CORRESPONDENCE.

On the occasion of a recent symposium on educational training in applied science, Professor Le Chatelier invited an expression of views and discussion of American practice by Professor Howe from whose reply are taken the following extracts which it is believed will be of interest to readers of the QUARTERLY.

MY DEAR PROFESSOR LE CHATELIER:

My own views (on higher technical training), for which you are so kind as to ask, may best be explained by referring to the teaching of metallurgy. This subject is not a science but an art, an art to be sure with a scientific foundation but still an art. How can we best plan the teaching of the young metallurgist so as to make him useful to his employer in the metallurgical works, and through this means to mankind as a whole? Shall we teach at our schools chiefly the science, or chiefly the art, or both equally?

The question really answers itself when we consider what the art is. Like other arts, it consists of manipulations, administrative arrangements, and mechanical operations. Of these a very great proportion do not need to be approached with any special scientific training; but certain ones do need such preparation. The best way of putting in the bottom of an open hearth furnace requires no more scientific knowledge than the proper cooking of a beefsteak. There is a vast number of things which stand on this same footing; they are details of manipulation pure and simple, the proper understanding of which requires no special scientific training.

But there are many other things which the metallurgist cannot perform understandingly without scientific training; and another very great number which he can understand much better or more easily after such a training. The scientific training which he is to receive is to fit him to do and understand these things.

Now it seems to me purely a matter of convenience and expediency what shall be taught at school and what learned in the works. In the study of analytical chemistry the manipulations are best taught at school and before graduation, because they are most easily taught there. It is a matter of expediency to teach them there. In the case of manufacturing chemistry many of the manipulations, like the manufacture of sulphuric acid in leaden chambers, are not easily taught in school, but are far more easily seen in the manufacturing establishments. Therefore the schools of chemistry do not set up leaden chambers, pyrites, kilns, Gay Lussac towers, and so forth, for making in school the great staple chemical products, solely because it is inexpedient. It is more convenient to show these manipulations in the works.

In the same way in metallurgy, there is a vast number of manipulations which the young graduate inevitably learns, and learns with great ease, spontaneously, soon after his entrance into the works. It is simply inexpedient to teach these in school, because it is much more expensive. Before he can be called an expert metallurgist he needs to have both his scientific foundation, and his knowledge of the manipulations of his art. But if on graduation he has the scientific foundation and even a very limited knowledge of the manipulations, he can begin being of use to an employer, and can begin earning money. Thenceforth in his remunerative work he inevitably becomes acquainted with the manipulative and administrative side of his art.

The superficial often speak as if it were essential that the young graduate, at the moment of his graduation, should already have arrived at a high degree of efficiency as an aid to his employer. That is not necessary. It is possible to give such efficiency at that time, but it is inexpedient. To give it, either the four years school course must be lengthened out greatly, or much of the scientific basis now thought very valuable must be omitted. It is more expedient to teach him at school those things which he can learn most readily at school, and make him at the time of graduation of moderate usefulness to his employer, leaving him to acquire in the easiest way in his paid employment in the works the practical information which could have been given him at school only with great difficulty, very slowly, and either at the cost of lengthening his school years or of omitting important scientific training.

No, it is a question of giving the student, not the maximum usefulness at the day of graduation, but the maximum usefulness in his whole life's work. He will have a greater sum of scientific plus technical knowledge at the end of say six years after beginning his studies if his four years at school are devoted chiefly to building a scientific foundation for his art, and if the manipulations of that art are learned in the following two years of practice in actual employment, than if he displaces a part of the scientific part of his school work with practical details, and enters the works on the day of graduation already familiar

with the practical details, but without further opportunity to get the scientific foundation. In this latter case he would have followed the path of greatest resistance, learning the technical details where they are hardest to teach, and coming already equipped with them to the works where he could have learned them so easily, but where he can no longer make up for the defects in his scientific training.

Hence, purely as a matter of expediency, and indeed as it seems to me of simple common sense, most American teachers confine the school teaching chiefly to building up the scientific foundation, giving only such acquaintance with the manipulative and administrative side of metallurgy as will aid in teaching the scientific side, by making the student understand the bearing and importance of the scientific matter taught him, by interesting him in his work, and by making it to a large degree concrete instead of abstract.

On page 10 you seem to imply that the habitual practice in this country is to give much training in industrial manipulation during the school instruction, sandwiched between parts of the scientific study. It is true that we send our students out during our summer vacations to study manipulations in the works, but very few of our educators approve of carrying the sandwich system farther than this, at least as regards metallurgy. We expect the students to get most of their practical knowledge after graduation.

The reason for sending them to the industrial works during their summer vacations seems to me purely administrative. One of the greatest difficulties that confront the president of a university is the breaking down of his teachers from overwork. The long summer vacation seems to be a necessity. It has been said that you can put twelve months work into eleven, but not eleven months work into twelve; that without a very considerable break in the teaching work, your teachers themselves break down.

This vacation existing, then, it is economical to use it to begin the students work of learning administrative and manipulative metallurgy. The plan to which you refer of having the student at school every other day, *i. e.*, three days in each week, and at work in some industrial establishment such as a machine shop on the other three days, has the serious defect of lengthening greatly the intervals between successive exercises in any given study. Because of the great number of subjects which must needs be studied, and because certain of these are prerequisite to others, and further because a student can profitably recite or listen to lectures in only a few hours in each day, the interval between successive exercises in any given subject must necessarily be long, regrettably long, even when the student is at school six days in every week. In many cases an interval from Friday morning to Monday morning, three whole days, seem practically an irreducible minimum, and in some cases a four day interval seems unavoidable. I do not know how such intervals can be avoided, because of the necessary conditions of the case. But during such an interval the impressions made on the student's mind at the last preceding exercises lose their sharpness and depth, as any observant teacher can see. The proposed plan of having only having three days schooling a week would naturally double these intervals. The present regrettable three and four day intervals would

be replaced by intervals of six and eight days, or more probably of seven and nine days, probably with great loss of efficiency of studying.

Much of the glib talk about revolutionizing technical study comes from men who have no personal knowledge of the art of teaching, its difficulties, and indeed its practical limiting conditions. It is a difficult and delicate art, no more to be dogmatized about by those who have never practiced it than any other art.

SOCIETY OF THE SIGMA XI.

The regular annual meeting of the Columbia, Kappa, Chapter of the Sigma Xi was held in Earl Hall, on the evening of April 22, for the purpose of initiating the new members and electing officers for the ensuing two years. The men initiated were as follows:

William M. Carpenter, Department of Civil Engineering.
Leonard D. Norsworthy, Department of Civil Engineering.
Trifon von Schrenk, Department of Civil Engineering.
Bragio P. Cerussi, Department of Electrical Engineering.
John E. Klein, Department of Electrical Engineering.
John J. Ryan, Department of Electrical Engineering.
W. L. Barrow, Department of Geology.
Paul Billingsley, Department of Geology.
Herbert J. Kohlberg, Department of Geology.
F. K. Morris, Department of Geology.
G. S. Rogers, Department of Geology.
Prof. A. L. Walker, Department of Metallurgy.
Richard F. Bohler, Department of Metallurgy.
George F. Comstock, Department of Metallurgy.
Harold E. Vehslage, Department of Mechanical Engineering.
W. B. Mucklow, Department of Mining Engineering.
Preston E. Locke, Department of Mining Engineering.
Willard L. Severinghaus, Department of Physics.
Burton W. Kendall, Department of Physics.
Clement S. Brainin, Department of Physics.
W. S. Melms, Department of Physics.
Dr. Norman E. Ditman, College of Physicians and Surgeons.

The officers elected were as follows:

Professor William H. Burr, President, from the Department of Civil Engineering.

Professor George F. Sever, Vice-President, from the Department of Electrical Engineering.

Dr. Chas. E. Morrison, Secretary and Treasurer, from the Department of Civil Engineering.

Dr. Charles P. Berkey, Corresponding Secretary, from the Department of Geology.

Professor Carlton C. Curtis, Counsellor, from the Department of Botany.

Over seventy members were present at the meeting, which was addressed by Professors Hallock, Burr, Kemp, Walker and Sever and Dr. George A. Soper, President of the Metropolitan Sewerage Commission.

BOOK REVIEWS.

Principles of Mining. Valuation, Organization and Administration; Copper, Gold, Lead, Silver, Tin and Zinc. By HERBERT C. HOOVER, Member Amer. Inst. Mining Engs., Mining and Met. Soc. of America, Soc. des Ingénieurs Civils de France, Fellow Royal Geog. Soc., etc. New York, Hill Publishing Co., 1909. Pp. vii + 199; 45 ills. Price, $2.50.

As set forth in the general headings of the table of contents this book deals with Mine Valuation, Development of Mines, Stoping, Methods of Supporting Excavations, Mechanical Equipment, Ratio of Output, Administration, Amount of Risk in Mining Investments and the Character, Training and Obligations of the Mining Engineering Profession.

In the past few years much has been written on the Valuation of Mines and kindred topics, in the shape of letters and contributions to several of the mining periodicals; and Mr. T. A. Rickard, in 1904, collected the best of this material in his book on "The Sampling and Estimation of Ore in a Mine," prefacing it by an extended and useful article of his own. But Mr. Hoover's work is, we believe, the first well-digested presentment of the entire subject.

The chapters on the technics of mining may be considered as written chiefly for the benefit of those who are not specially conversant with the details of mining methods and practice. Though these chapters are necessarily brief, in proportion to the largeness of the subject, they cover the general principles so admirably and are so well written and illustrated that they will be read with not less pleasure than profit by mining engineers.

On the difficult subject of Mine Valuation few engineers are fully competent to write. Mr. Hoover analyzes it clearly and concisely under the heads: Determination of Average Metal Contents of the Ore, Determination of Quantities of Ore, Prospective Value, Recoverable Percentage of Gross Value, Price of Metals, Cost of Production, Redemption or Amortization of Capital and Interest, Valuation of Mines Without Ore in Sight, and General Conduct of Examination and Reports. Under the first of these heads the knotty questions of calculation of average values, the percentage of error in estimates from sampling and the debatable significations of the expression, "ore in sight," are discussed in a very satisfactory manner. Referring to the last-mentioned topic, the author adopts a simple and very reasonable classification, namely:

"*Proved Ore.* Ore where there is practically no risk of failure of continuity.

"*Probable Ore.* Ore where there is some risk, yet warrantable justification fo rassumption of continuity.

"*Prospective Ore.* Ore which cannot be included in the above classes, nor definitely known or stated in any terms of tonnage."

In the interpretation of data relating to the second and third of these classes, Mr. Hoover discusses at some length the origin and structural character of ore deposits. The following quotation indicates the sanity of his views concerning this vital subject: "Geologists have, as the result of long observation, propounded for us certain hypotheses which, while still hypotheses, have proved to account so widely for our underground experience, that no engineer can afford to lose sight of them. Although there is a lack of safety in fixed theories as to ore deposition, and although such conclusions cannot be translated into feet and metal value, they are nevertheless useful weights on the scale where probabilities are to be weighed." Nothing could more clearly indicate, among other things, that knowledge plus experience are essential elements in the equipment of one who undertakes to value a mine, and should give pause to young engineers and others, who, possessing a little knowledge but no experience, yet venture to write "reports." Not a few go into this branch of mining engineering with the idea that industry in "taking samples" is the chief, if not the only, requisite.

The current view that mining involves risks beyond those of many mercantile pursuits is true only in part. Mr. Hoover is one of those who believe that mining operations may and should be conducted on reasonable business lines and that by the exercise of knowledge and skill such risks as are rightly considered inevitable may be minimized. A mine is not necessarily a lottery and the day of treating mining investments merely as "flyers," for the employment, not of capital, but of nothing more serious than surplus income, is passing. Just at this time, it is announced that one of the largest of the great French banks has begun to invest in certain South African gold mines (such as the Crown and the Ferreira), and is advising its clients respecting mining investments. Some conservative private banking houses in this country have their mining interests well cared for by competent engineers and managers. Such things would have been impossible but a few years ago, and they indicate a change of view respecting the industry that cannot fail to be beneficial.

Other valuable chapters are those on the Cost of Production and the Amortization of Capital and Interest. Mr. Hoover's remarks in Chapter XX. on the "Character, Training and Obligations of the Mining Engineering Profession" are excellent and constitute a fitting close to a thoroughly good book.

R. P.

Sanitation and Sanitary Engineering. By WM. PAUL GERHARD, C.E. New York, published by the author, 1909. Pp. 175.

This volume is one of a series of works on general sanitary and hygienic subjects, which have appeared from time to time from the pen of this author. The present volume is a second, revised and enlarged edition. In the opinion of the reviewer much of the matter included in this work would make excellent material for addresses to be delivered before municipal boards or civic societies interested in the reform of sanitary conditions, but is less suitable to a work which seriously treats of sanitation and sanitary engineering. Nevertheless, the volume is

interesting in touching upon a great variety of subjects, some of them not usually to be found in this class of work. Perhaps because it attempts to cover so wide a field it can scarcely be expected to do more than call general attention to many of the topics considered, while giving more detailed information in the case of the more important. In the author's outline of the sanitary engineering courses offered in some of the universities in this country, he mentions the special course of lectures on sanitary science and public health, delivered under the auspices of Columbia University during the current academic year, together with the various topics treated. Had the publication of this book been delayed a few months, the author would undoubtedly have also included an outline of the new four-year course in sanitary engineering which Columbia is now offering. On the whole Sanitation and Sanitary Engineering is an interesting book for that class of readers who desire general rather than detailed and specific information; and it conveys, perhaps better than would a more ambitious work, an excellent idea of the scope and importance of the work of the present-day sanitary engineer. A. B.

Metallurgy; A Condensed Treatise for the Use of College Students, and Any Desiring a General Knowledge of the Subject. By HENRY WYSOR, B.S. Assistant Professor of Analytical Chemistry and Metallurgy in Lafayette College, Easton, Pa. Published by the Chemical Publishing Co., 1908. First edition. 8vo; 308 pages; 82 illustrations and 7 curve plates. Price $3.00.

There is need of such a book, as the author states, in the preface, was his desire to write, which is: "A guide to the science of metallurgy . . .; setting forth the principles involved . . .; admitting only such matter as is essential to the student"; and, "a condensed manual, . . . which will be of assistance to students, teachers, and others, who need some general information in different branches of metallurgy."

The reader's first impressions of the book, on glancing through it, were favorable; but later, when the chapters were perused, he was disappointed on finding that the author had either carelessly, or else unknowingly, made a number of metallurgical mistakes in the chapters on copper, lead, silver and gold.

The subjects which are presented in twenty-eight chapters are: Physical Properties of Metals; Refractory Materials, Fluxes and Slags; Theory of Combustion and Thermal Measurements; Classification and Description of Fuels; Ore Dressing; Furnaces; Iron Ores and Properties of Iron; Iron Smelting; Properties and Uses of Cast Iron; Steel Manufacture; Treatment of Iron and Steel; Copper Ores and Properties of Copper; Copper Smelting; Copper Refining; Lead Ores and Properties of Lead; Roasting, Smelting and Refining of Lead; Zinc Ores, Properties, Smelting and Refining of Zinc; Properties Smelting and Refining of Tin and Mercury; Silver Ores, Extraction and Refining of Silver; Gold Ores, Extraction and Refining of Gold; The Ores, and the Extraction and Refining of Nickel, Aluminium, Manganese, Chromium, Tungsten, Vanadium, and Platinum; Alloys, Welding, and Plating.

The author, in attempting to cover such a broad subject as general metallurgy in so few pages, overlooked essential metallurgical principles in his descriptions of the methods of treatment. In a number of cases, in the chapter on copper, lead, silver, gold and the minor metals, theoretical chemical reactions were applied in their metallurgical treatment, and also several impossible reactions are given. In the introduction, it is stated that "metallurgical processes are essentially chemical"; this is true; however, the economical treatment of an ore is in an exceptionally few cases carried out according to theoretical chemical principles. What is really done in practice is to conduct the work in the shortest time, and at the lowest cost, even though a complete recovery of the metal, or metals, is not accomplished. It is disappointing that the author did not make himself familiar with the practical metallurgy of copper, lead, silver, gold, and nickel, before writing the book. As an evidence of this, the chapters on iron and steel (VIII. to XVII., inclusive, pp. 65–169) are well written, and the metallurgical principles are handled in a concise, elementary manner. The chapter on zinc (XXIII., pp. 231–239) is good but in limiting it to such a few pages, some important and essential features have been overlooked.

The book, as a whole, shows that the author gave his work much study. The writing of a satisfactory book on metallurgy, which is truly an applied science, is a difficult task, and cannot be done by consulting the literature alone. It is the author's lack of having seen the operations in practice, which renders the book less suitable as a text-book for colleges.

The book is well edited; it is printed in clear-cut types, and with very few typographical errors. The illustrations are excellent, and were well selected to show the most important apparatus which are used for the methods of treatment described.

E. F. K.

Alloys and Their Industrial Applications. E. F. Law. London, Charles Griffin and Company. Phila., J. B. Lippincott Co. 1909. 269 pages, 44 photomicrographs. $4.00 net.

This book forms one of the Griffin Metallurgical Series and is divided into sixteen chapters as follows. Introduction. Properties of alloys. Methods of investigation. Constitution. Influence of temperature on properties. Corrosion of alloys. Copper alloys, bronze. Brass. Special bronzes and brasses. German silver and miscellaneous copper alloys. Whitemetal alloys. Antifriction alloys. Aluminium alloys. Silver and gold alloys. Iron alloys. Miscellaneous alloys.

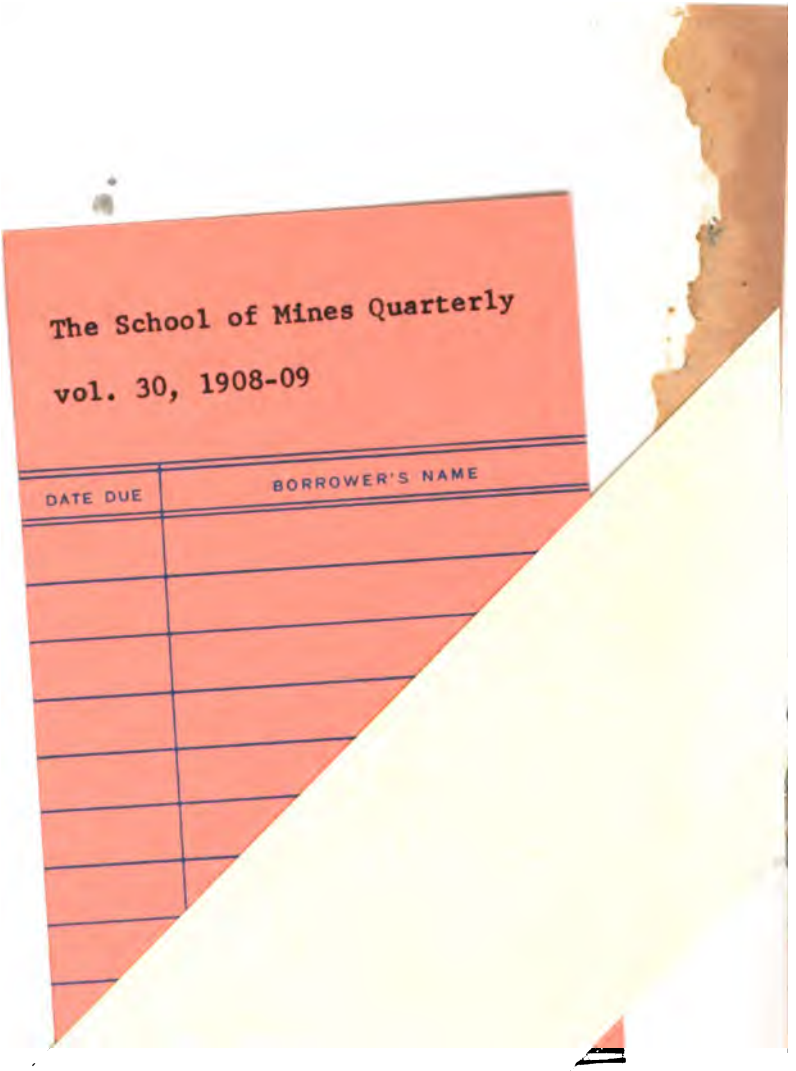
Taking the book as a whole, the author is to be congratulated on giving us an excellent insight into the nature and properties of alloys, in a readable, clear and simple manner. After reading it as a text-book, however, one has a number of criticisms to offer as to the method of treatment. Yet going back to the preface, the author states that this is an attempt to present the subject in such a manner that it will be intelligible not only to the student but also to the manufacturer and the engineer for whom indeed the volume is primarily intended. For that

reason the alloys chosen are those of industrial importance, whilst the recent work of the German metallographers, such as Tammann's students and others, on the constitution of the various binary alloys, has been omitted. We feel that had this work been taken into consideration a book much more valuable to the student would have been produced, for it seems that something has been sacrificed by "hesitating to plunge into the intricacies of solid solutions, hyper-eutectics, solidus curves and phases." Would not the complete curve for the copper-aluminium series be better than one indicating merely the beginning of freezing? Again, in describing the copper-nickel alloys and the German silvers, curves would make the constitution much clearer to most people. Criticisms on the contents are on minor points, such as the assuming that true alloys can be formed by pressure, following Spring. This has not been conclusively proved and is probably not so. Again, the author states that the rate of cooling determines the grain size of ordinary alloys, whilst it is really the rate of passing through the freezing range. Again, under the heading of the iron-carbon system the two theories of constitution which have been so much to the fore of late are not brought out, and yet the Ar_0 point is mentioned and spoken of as being due to change in the tube in which the cooling takes place. This Upton (*J. Phys. Chem.*, 13, 392) has shown is not so.

At the end of the book there are some excellent micrographs most beautifully reproduced. The book is well printed and prepared like the rest of the Series.

W. C.

SER.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BORROWER'S NAME

U. S. A.